AD-A049 462 GTE SYLVANIA INC NEEDHAM HEIGHTS MASS COMMUNICATIONS--ETC F/G 17/2.1
TRAFFIC FLOW, PERFORMANCE AND INTERFACE CHARACTERIZATION STUDY --ETC(U)
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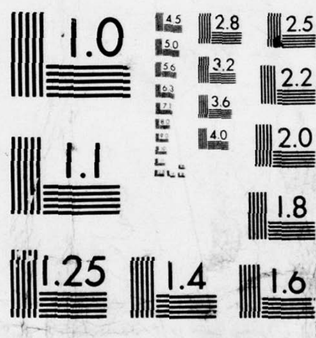


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

PRC	RTE	TRM TG/TK	ORG SWC	TRM SWC	AGENCY	MODE	GR	ORIG TEL	DATE	HOLDING TIME
		1609	LKF				V		120176	000018
2	0	1300	LKF				V		113076	000005
4	0	1704	LKF				V		113076	000005
4	0	8809	LKF				V		113076	000004
4	0	8805	LKF				V		113076	000004
2	0	8810	LKF				V		120176	000027
4	0	8801	LKF				V		120276	000055
4	0	1503	LKF				V		120276	000007
4	0	8003	LKF				V		112976	000243
2	0	8000	LKF				V		113076	000112
4	0	1506	LKF				V		120176	000005
3	0	8311	LKF				V		120276	000204
2	0	8001	LKF				V		113076	000357
4	0	8803	LKF				V		112976	000032
2	0	1200	LKF				V		113076	000014
4	0	8813	LKF				V		120276	000230
4	0	8005	LKF				V		113076	000123
4	0	8000	LKF				V		120276	000120
4	0	1507	LKF				V		120276	000005
4	0	8002	LKF				V		120276	000145
2	0	8[illegible]4	LKF				V		120176	000036
2	0	8005	LKF				V		120276	000093
2	0	8005	LKF				V		120276	000004
2	0	8[illegible]5	LKF				V		120276	000238
4	0	1505	LKF				V		120176	000005
4	0	8803	LKF				V		120276	000304
4	0	8807	LKF				V		113076	000404
3	0	8811	LKF				V		113076	000044
2	0	8806	LKF				V		113076	000009
2	0	8802	LKF				V		113076	000024
3	0	8804	LKF				V		113076	000014
4	0	8206	LKF				V		113076	000144
3	0	8211	LKF				V		120176	000902
2	0	8203	LKF				V		120176	000142
4	0	8205	LKF				V		120276	000130
2	0	8213	LKF				V		120176	000110
4	0	8812	LKF				V		113076	000050
4	0	8902	LKF				V		120276	000016
4	0	8811	LKF				V		120276	000019
4	0	8803	LKF				V		120276	000014
4	0	2101	LKF				V		120276	000035
4	0	1503	LKF				V		120276	000004
4	0	1504	LKF				V		120276	000005
4	0	1505	LKF				V		120276	000004
3	0	1205	LKF				V		120276	
4	0	1506	LKF				V		120276	000004
4	0	1505	LKF				V		120376	000004
4	0	1507	LKF				V		120376	000003
4	0	1501	LKF				V		120376	000004
4	0	1503	LKF				V		120376	000005
4	0	2126	LKF				V		120376	000035
4	0	2126	LKF				V		120376	000017
4	0	1506	LKF				V		120376	000004
4	0	1507	LKF				V		120376	000004
2	0	8903	LKF				V		113076	000149

Figure A-5. Call Data Listin

Table A-1
List of Report Attributes

Attribute Name	Description
ORGTG	Two digit originating trunk group number
ORGTK	Four digit originating trunk number
ITLTIM	Six digit initial time (HHMMSS)
ITLHR	Two digit hour of initial time
RELTIM	Six digit release time (HHMMSS)
DIALAC	Three digit dialed area-code
DIALDG	Seven digit dialed digits
PRC	One digit precedence
TRMTG	Two digit terminating trunk group number
TRMTK	Four digit terminating trunk number
ORGSWC	Three character originating switch name
GRADE	One character grade
DATE	Six digit date (DDMMYY)
HLDTIM	Six digit holding time (MMHHSS)

In addition to lists of the data, a series of special purpose subroutines were required to make many of the reports for the European Traffic Study. These subroutines were included in the report generation program. The subroutines are entered from the main program when the conditions specified in the subroutine request card.

The following is a list of the subroutines created for special reports from the call data base.

1. Originating Trunk Occupancy — the amount of time that a trunk is in use for originating calls is calculated on a per hour basis. To calculate the time, the holding times are summed for each trunk. In addition, 2.2 seconds are added for each dialed digit. The output is given in total seconds, and percentage of the hour.
2. Terminating Trunk Occupancy — the amount of time that a trunk is in use for terminating trunks is calculated on a per hour basis. To calculate the time, the holding times are summed for each trunk. The output is given in total seconds and percentage of the hour.
3. Count of calls to Area Code or NNX by switch — The number of calls originating at a switch to each distinct Area Code or NNX is counted. The counts are given in both total number of calls and number of calls with holding times greater than or equal to 25 seconds.
4. Count of calls to Area Code or NNX by Switch by originating trunk — A count exactly as in (3) except the summary is further broken down to originating trunks.

5. Count of Calls to Phone Number by Switch — the number of calls to each distinct phone number from a given switch is counted. The outputs are given in both total calls, and those with holding times greater than or equal to 25 seconds.
6. Count of Calls to Phone Number by Switch by Originating Trunk — a count exactly as in (5) except the summary is further broken down by originating trunks.
7. Force Element Summary Runs — four different sets of runs were identified as necessary to perform the force element analysis. In order to describe the reports, a brief description of the force element is given here.

Figures 5-1 through 5-6 in Section 5 illustrate these various call data reports. The force element consists of a four digit numerical value. The first two digits are referred to as the force element category. The entire four digits is referred to the force element code and is a finer breakdown of force elements within each category.

The set of four force element runs is described as follows. Note that these runs use the edited form of the data base.

1. Base to Force Element Category —
   The number of calls from each base to each force element category is counted. The summation is split into two units, precedence calls from a base and routine calls from a base. Two counts of calls or given, one is total number of calls and the number of calls with holding times greater than 25 seconds.
2. Base to Force Element Code—
   This count is described exactly as (1) except the calls are counted to the entire four digit force element code.
3. Base to Force Element Category to Base —
   The number of calls, split out again by precedence and routine, from each base is counted to a force element category on each unique called base. Again two counts are given, one of total calls and another of calls with holding times greater than 25 seconds.
4. Base to Force Element Code to Base —
   This count is described exactly as in (3), except the calls are counted to the entire four digit force element code.

Appendix B
U.S. Army Service Observing Data

1.0 Introduction

The U.S. Army 5th Signal Command has several Siemens Traffic Flow measuring devices (VAM) for use in analysis of the traffic on its direct distance dialing (DDD) telephone network in Europe. This appendix outlines the basic features of the VAM and summarizes the computer program package developed by GTE Sylvania used to reduce the VAM data to formatted records and statistical summaries. Samples of the final reports generated are included, together with commentary on the interpretation of these reports.

2.0 The VAM Unit

The Siemens VAM unit is designed to monitor the supervision lines in a telephone central office for the purpose of obtaining:

1. Dialed digits
2. Off-hook time
3. Dialing time
4. Call termination time
5. Call disposition

How the VAM obtains and processes this data is the subject of this section.

The VAM is connected to the supervision lines of up to 24 telephone trunks during a study period, but it can follow the call build-up for only one trunk at a given instant. The VAM scans the trunks under consideration until it sees one that is just initiating a call (call for service). The VAM then locks into that trunk, ignoring any attempts to initiate calls on the other trunks until the call build-up on the watched trunk is completed. When the build-up is completed, the VAM proceeds once again to scan the lines, looking for the initialization of another call.

When referring to call build-up, one usually means the process of a telephone call being transferred through a central office. The build-up is completed when the connection through to the other side has been completed (or the call has been aborted before through connection is completed). The VAM, however, has an operational definition of build-up completion which is somewhat different, owing to the one-trunk-at-a-time nature of the device. The VAM follows call build-up for the time required to dial a certain number of digits. This number of digits is selectable via a thumbwheel switch as two to ten digits. Thus, the VAM unlocks from a given trunk and starts to scan again when the selected number of dialed digits has been seen (or the call aborted for one of several reasons prior to total dialed digits seen). This feature allows the VAM user to trade off between number of calls recorded (fewer dialed digits recorded allows more calls to be seen) and accuracy in determination of call disposition and call destination (the fewer dialed digits recorded, the more chance that the complete number was never actually dialed).

The VAM also records the termination of phone calls. Unlike the operation of the VAM in call initialization, however, the monitoring of call termination is not exclusive to one trunk at a time. All terminations for which initializations were recorded are seen and recorded when they occur.

The data messages from the VAM are recorded on paper tape in the CCITT No. 2, 5-level baudot code. There are five types of call disposition monitored by the VAM. Each type of call disposition is represented in the data message by a unique symbol. The five types of call disposition and their associated symbols are:

1. '-' Selected number of digits received. This call disposition symbol indicates that the VAM had followed the call build up as far as specified by the user.
2. '=' An unsuccessful call released by the subscriber. The caller has gone on-hook before completing the minimum number of dialed digits.
3. '(' Interruption of observation because time for dialing the required number of digits exceeded 30 seconds.
4. '+' Observation interrupted for technical reasons.
5. '&' One or more pulses in a pulse train exceeds 100 ms. The digit is unrecognizable to the VAM.

The format for the call initialization (attempted) message is as follows:

TT IIIII N...N S DDD XX

where

TT	is the 2-digit trunk number (01 to 24) of the line under observation.
IIIII	is 5-digit time entry, in seconds, denoting the time of call initialization.
N...N	is the dialed digits received (2-10 digits).
S	is the symbol for the disposition of the call.
DDD	Are the 3 least significant time digits, indicating end of dial time (example, if IIIII is 27473 and DDD is 492, dialing was completed at 27492, for a total dialing time of 19 seconds).
XX	is the 2-digit day entry (XX is set to 00 on the first day of measurement).

When the VAM records all required digits, for a certain call, and thus considers that call complete, it also punches an end-of-call message when the call is terminated. The message is of the form:

TT FFFFF XX

where

TT and XX are previously defined and FFFFF is the 5-digit time entry marking the termination.

In addition to punching out the actual data messages, the VAM separates each data message by a line feed-carriage return to facilitate decoding. Figure B-1 shows a typical sample of data messages as they would appear reproduced on a Teletype printer.

3.0 Computer Processing of VAM Data

In order to utilize the information collected by the VAM, GTE Sylvania has developed a group of FORTRAN-based computer programs. The programs are applied to the VAM data tapes, which have first been transferred to magnetic tape for ease in handling and system compatibility. These programs, broken down along functional lines, serve to (a) search the data base (the VAM data) for illegal conditions and respond, (b) sort and format the data into call records, (c) identify called parties using the dialed digits field, and (d) produce statistical summaries of the data.

3.1 Error Trapping

The raw VAM data as found on the output paper tapes is quite often scarred with errors of several kinds. Three major types of errors often found are missing line feed-carriage return characters, extraneous characters prefixing data messages and the retrogression of time entries in the data messages.

The carriage return-line feed (LF-CR) pair is used by the VAM to delimit records, but often one or even both of the characters are absent between messages. Thus two or more messages look to the data reduction program like one overly-long, ill-formatted message which cannot be processed.

It was also found that occasionally data records are preceeded by a variable number of extraneous characters (see Figure B-2). There is reason to believe that this is the result of some power-up phenomenon after the power has been momentarily lost. In any event, the result is unusable by the reducing program.

Missing LF-CR and extraneous characters both produce errors which will cause the reducing program to fail catastrophically, that is, to cease processing and print a system error message. The third systematic error type, the retrogression of time entries, is not catastrophic in the above sense. Rather, the data is accepted by the reducing program, but the results are meaningless.

Retrogression of time entry is the situation in which the time entry of one or more data messages indicates that the message(s) was (were) generated before another message which had in actuality been generated first (see Figure B-3). The following scenario illustrates this phenomenon: The study starts at 0900 hours, and this time is input to the VAM. After a record is output to the paper tape at 1306 hours (or 46980 seconds, as it appears on the tape), the unit goes down (for whatever reason). When the VAM is turned back on, the technician attending to it must input

```
075914433338-15800
245920500
225925900
225927232355-23200
00593444=34700
225937400
125942034245-43700
09594533222(47300
125946500
105947522236=48400
075943000
07595642311(57600
21595311141(59300
055959713174-60900
225961623175-62400
225963400
225971621183-72500
00597525311(76600
055980300
245986222274-86900
065987323173-88000
245990700
225996500
07599903531(00600
075002453338-03900
076004600
0760049353(06200
066011500
05601338=13400
2260174665=17700
08602618=26300
```

Initialization-Termination Pair

Time Exceeded Interruption

Subscriber Release-Unrecognizable Digit

Figure B-1. VAM Raw Data Sample

```
123496802
09349787614=98502
09349877613S-00302
04350032116=01402
21350142116=02502
21350272116=03202
21350332116=04502
21350482116=05902
213506121132-07103960939617223S=62602     ← 2 Data Messages
243962716=53102                               Without Line Feed -
243963216=63602                               Carriage Return
243963716=64102                               Separation
24396412326=65002
24396522326=67102
2439674S=67602                                Extraneous Digits
093969322059-70402
22397108454&-72202
223972202
```

Figure B-2. VAM Raw Data Sample

```
11367551 2& =76002
11367621& =76702
223676712 1& =77502
113677712& =78202
19367833 11& =79102
22367933& =79902
1936801311 76-31902
                    3600636003 22 3& =01102
0936012 22 3& =02102
06360 3222 3& =04002
09360412 23& =04902
06360522 2 3& =05002
093606122 3& =05902
05360 74& =07602
0636081 533& =09502
```

Retrogression of Time Entry

Figure B-3. VAM Raw Data Sample

the starting time. The time that the unit went down (1306) is not available to the technician, however, and by his wrist watch he restarts the VAM at 1300 hours. A data message is punched with a time field of 46800 which looks as though it happened *before* the previous message at 46980. This retrogression of time order causes the process of matching originating and terminating data messages to mismatch, potentially destroying the integrity of all data in that section of that particular tape.

In order to deal with the error types described above, as well as with others, the tapes are first processed through an error-trap program which effectively prefilters the data base. This program employs several different debugging techniques to insure that only useful data gets carried into the call record producing stage.

The prevalent debugging technique is one which employs a pattern recognition algorithm to flag nonconforming data messages. The algorithm follows this general scheme: Data messages are read into a data buffer, character by character, until an LF and/or CR is encountered. The contents of data buffer are then tested for conformity to a generalized set of data message characteristics, such as proper total number of characters, existence of call disposition symbol (this test differentiates between initialization and termination messages), position of disposition character in data message and value bounds on various number fields of the message (for example, in any data message, the first two digits must lie between 01 and 24 indicating the trunk number). If a nonconformity is seen, the program flags the record on the hard-copy output generated by the program. Furthermore, if the error is determined to be one of a set for which corrective procedures have been established, the program will attempt to correct the error. In this way the problems of both missing LF-CRs and extraneous digits are solved (see Figure B-4, input line number 1063).

Another facet of the error-trap program is directed at the retrogression of time entry situation. As the output data base is being created a sequence number (actually, the output line number as seen on Figure B-4) is affixed to each message. Thus, when the call record producing stage is entered, the data messages are sorted according to this sequence number field and the actual time sequence of the data is preserved.

At this point the program user has at his disposal an error-editing program which can be used to delete or alter those errors merely flagged but not corrected by the error-trap program.

3.2 Call-Record Formatting

After the data base has been purged of errors, the data base is sorted, merged and reformatted to form call records which are more suited to visual and machine analysis. The record-formatting process has two major components: combining

	INPUT LINE NO.	INPUT RECORD		I / T	OUTPUT LINE NO.	OUTPUT RECORD
	1049	105860328160-61502		I	1050	105860328160-61502
****	1050	2058615=	**********	I	1051	2058615=
	1051	095862720(66002		I	1052	095862720(66002
	1052	105862802		T	1053	105862802
	1053	085866422176-67702		I	1054	085866422176-67702
	1054	125868052161-69402		I	1055	125868052161-69402
	1055	085868502		T	1056	085868502
	1056	185869814162-71702		I	1057	185869814162-71702
	1057	115873414170-74702		I	1058	115873414170-74702
	1058	2458758711=76402		I	1059	2458758711=76402
	1059	115876202		T	1060	115876202
	1060	125876802		T	1061	125876802
	1061	045877402		T	1062	045877402
	1062	045877622371-78502		I	1063	045877622371-78502
****	1063	071007106707100800288182880311=80802	**********	I	1064	182880311=80802
	1064	182880822174-81902		I	1065	182880822174-81902
	1065	02288231226=82802		I	1066	02288231226=82802
	1066	122882911=83702		I	1067	122882911=83702
	1067	182883002		T	1068	182883002
	1068	122884211=84702		I	1069	122884211=84702
	1069	122884812274-86402		I	1070	122884812274-86402
****	1070	0228876=	**********	I	1071	0228876=
	1071	042887722182-88402		I	1072	042887722182-88402
	1072	02288856226=89202		I	1073	02288856226=89202
	1073	152889422831-90902		I	1074	152889[illegible]2831-90902
	1074	152891002		T	1075	152891002
****	1075	1728912=	**********	I	1076	1728912=
	1076	182891322174-92302		I	1077	182891322174-92302
	1077	232892429019 6002		I	1078	23289242901 96002
	1078	182893602		T	1079	182893602
	1079	152896220(00102		I	1080	152896220(00102
	1080	212900622176-01602		I	1081	212900622176-01602
	1081	10290182151=02702		I	1082	10290182151=02702
	1082	212902402		T	1083	212902402
	1083	19290282151=03802		I	1084	19290282151=03802
	1084	232904629C(08102		I	1085	232904629 0(08102
	1085	042909102		T	1086	042909102
	1086	092909812116-10502		I	1087	092909812116-10502
	1087	092910502		T	1088	092910502
	1088	022911028165-12002		I	1089	022911028165-12002
	1089	092912712111-13402		I	1090	092912712111-13402
	1090	092913502		T	1091	092913502
	1091	092913922186-14502		I	1092	092913922186-14502
	1092	012915322874-16702		I	1093	012915322874-16702
	1093	092917102		T	1094	092917102
	1094	162917222183-17902		I	1095	162917222183-17902
****	1095	2881528803=	**********	I	1096	1528803=
****	1096	1528810=	**********	I	1097	1528810=
	1097	012881322184-82902		I	1098	012881322184-82902
	1098	072883113183-84302		I	1099	072883113183-84302

Figure B-4. VAM Error Correcting Program Sample

initialization and termination entries for completed calls into single call data records, and calculating off-hook and dial time (and holding time for completed calls).

In order to create a single record for each attempted telephone call, the initialization and corresponding termination entry must be matched. This grouping is accomplished by sorting the data base with a trunk number/sequence number sort key (the sequence number is used instead of the time entry for reasons previously stated). By this process, all termination entries directly follow their corresponding initialization entries in the resorted data base. It is then a simple process to group the entries.

Once a complete data record has been formed, a simple formula is employed to convert the total-seconds format of the initialization time, dialing time, and termination time entries into initialization time, dialing time, and holding time entries in a format of hours-minutes-seconds.

A final, and somewhat secondary, function of the record-formatting program is to recognize and flag what are termed "incomplete" entries. By incomplete is meant an initialization entry for which no termination entry exists. Such a condition comes about when the VAM is shut down for a period during which calls terminate for which initializations have been recorded. These incomplete calls are flagged by the symbol "I" in the call disposition symbol field.

3.3 Called Party Identification

Of special interest to the traffic flow study is the identification of the location of the called parties. This identification is accomplished by comparing each record to a computer-based directory of the military dial prefixes for the Army in Germany. The outcome of this comparison is one of three conditions. If the number of digits dialed are sufficient to uniquely identify the terminal point, the transaction is identified as such. If the digits dialed are sufficient to determine that no number in the directory could correspond, the call is termed a "misdial". Finally, if two or more phone numbers could correspond to the dialed digits such that no unique match exists, the call is labeled for "insufficient digits".

Once the dialed digits have been classified, the called party classification is appended to the record in the data base. This new data base can now be sorted in various ways, such as sort-by-trunk and sort-by-time. Figure B-5 is a page from a trunk-sort report, and Figure B-6 is time-sorted.

3.4 Statistical Summary Generation

The last phase in the reduction of the VAM data base involves the generation of statistical summaries of quantities of interest. The summaries produced can be segmented into two basic types: holding time/call disposition statistics, and relative distribution of called number statistics.

GIESSEN CLASS A1 & A2 -TRUNK SORT

TRK NO.	DAY	DIALED DIGITS	I S C	OFF-HOOK TIME H	M	S	DIAL TIME M	S	HOLDING TIME H	M	S	DIALED DIGITS IDENTIFIER
01	00	233380	-	9	5	13	0	10	0	1	4	KIRCHGOENS
01	00	23181	=	9	7	22	0	12				WIESBADEN
01	00	284723	-	9	7	36	0	11	0	0	11	VON LINDSEY PBX
01	03	231151	-	8	40	35	0	16	0	0	9	FRANKFURT
01	03	21311	=	10	45	27	0	7				MANNHEIM
01	03	211	=	11	0	59	0	4				MISDIAL
01	03	211	=	11	1	5	0	4				MISDIAL
01	03	211	=	11	1	11	0	3				MISDIAL
02	00	233380	-	8	0	8	0	16	0	2	50	KIRCHGOENS
02	00	23141	=	8	26	36	0	7				DRAKE KASERNE
02	00	23091	=	8	27	3	0	9				HU/FLIEGERHORST
02	00	21411	=	8	42	43	0	20				KARLSRUHE
02	00	284346	-	9	0	19	0	9	0	0	44	VON MANNHEIM PBX
02	00	236468	-	9	44	15	0	20	0	4	6	FULDA
02	00	23631	=	9	56	19	0	16				BAD HERSFELD
02	00	21211	=	10	24	23	0	6				HEIDELBERG HDG
02	00	23121	=	10	54	53	0	11				FRANKFURT HOSP
02	00	231276	-	10	55	6	0	15	0	0	10	FRANKFURT HOSP
02	00	235389	-	11	13	17	0	17	0	1	33	WACKERNHEIM
02	00	23121	=	13	12	5	0	11				FRANKFURT HOSP
02	00	23011	=	14	17	34	0	16				FRIEDBERG
02	00	230987	-	14	23	13	0	17	0	0	8	HU/FLIEGERHORST
02	00	23141	=	14	24	56	0	12				DRAKE KASERNE
02	00	230181	-	15	0	2	0	19	0	0	15	FRIEDBERG
02	00	233774	-	15	0	44	0	13	0	0	6	BUTZBACH
02	00	23111	=	15	6	32	0	10				FRANKFURT
02	00	23011	=	15	33	50	0	14				FRIEDBERG
02	00	284541	-	15	38	34	0	15	0	0	15	VON SPNGDHLM PBX
02	00	21211	=	15	39	46	0	7				HEIDELBERG HDG
02	00	237185	-	18	38	45	0	7	0	0	12	DARMSTADT
02	03	231171	-	8	43	2	0	14	0	10	39	FRANKFURT
02	03	23111	=	9	37	44	0	10				FRANKFURT
02	03	284346	-	9	40	55	0	8	0	0	28	VON MANNHEIM PBX
02	03	23711	=	9	47	1	0	11				DARMSTADT
02	03	23711	=	9	47	16	0	11				DARMSTADT
02	03	233380	-	9	49	7	0	16	0	3	0	KIRCHGOENS
02	03	233781	-	10	14	16	0	11	0	0	1	BUTZBACH
02	03	23011	=	10	59	25	0	8				FRIEDBERG
02	03	21311	=	13	43	43	0	9				MANNHEIM
02	03	21311	=	13	43	56	0	10				MANNHEIM
02	03	284246	-	13	44	10	0	25	0	0	11	VON RAMSTEIN PBX
02	03	21311	=	13	44	51	0	6				MANNHEIM
02	03	21311	=	13	45	35	0	7				MANNHEIM
02	03	21311	=	13	45	44	0	7				MANNHEIM
02	03	21311	=	13	45	55	0	8				MANNHEIM
02	03	21311	=	13	46	7	0	9				MANNHEIM

INTERRUPTION STATUS CHARACTERS - '-' SEIZURE, '=' SUBSCRIBER RELEASE,
'(' VAM INTERRUPTION OF OBSERVATION, 'I' NO TERM ENTRY, '+' TECH INTERRUPTION

Figure B-5. VAM Trunk Sort Report Sample

GIESSEN CLASS A1 & A2 - TIME SORT PAGE 1

TRK NO.	DAY	DIALED DIGITS	I S C	OFF-HOOK TIME H M S	DIAL TIME M S	HOLDING TIME H M S	DIALED DIGITS IDENTIFIER
02	00	233380	-	8 0 8	0 16	0 2 50	KIRCHGOENS
21	00	231181	-	8 0 25	0 13	0 2 27	FRANKFURT
19	00	231161	-	8 0 41	0 12	0 1 52	FRANKFURT
15	00	23111	=	8 0 56	0 6		FRANKFURT
24	00	23148	=	8 1 15	0 11		DRAKE KASERNE
24	00	22836	=	8 1 26	0 11		MISDIAL
24	00	22866	=	8 1 41	0 13		MISDIAL
24	00	228365	-	8 1 57	0 15	0 0 11	MISDIAL
13	00	22311	=	8 2 15	0 9		BAUMHOLDER
13	00	22311	=	8 2 27	0 11		BAUMHOLDER
13	00	22311	=	8 2 41	0 10		BAUMHOLDER
24	00	231162	-	8 2 52	0 11	0 0 10	FRANKFURT
13	00	223171	-	8 3 8	0 18	0 2 21	BAUMHOLDER
24	00	231157	-	8 3 58	0 12	0 0 10	FRANKFURT
10	00	231164	-	8 4 17	0 14	0 10 3	FRANKFURT
12	00	231263	-	8 4 40	0 15	0 0 39	FRANKFURT HOSP
24	00	213661	-	8 5 11	0 15	0 0 30	RHEINAU
12	00	230170	-	8 5 56	0 19	0 0 9	FRIEDBERG
24	00	213661	-	8 6 24	0 16	0 15 56	RHEINAU
21	00	2581	=	8 6 41	0 9		AUGSBURG
19	00	231173	-	8 6 51	0 13	0 5 14	FRANKFURT
21	00	230171	-	8 7 14	0 26	0 0 15	FRIEDBERG
12	00	230170	-	8 8 12	0 17	0 0 8	FRIEDBERG
21	00	231165	-	8 8 33	0 14	0 3 2	FRANKFURT
12	00	230170	-	8 9 6	0 16	0 0 10	FRIEDBERG
17	00	230987	-	8 9 41	0 18	0 0 8	HU/FLIEGERHORST
17	00	23511	=	8 10 27	0 16		MAINZ
17	00	235183	-	8 10 45	0 18	0 0 16	MAINZ
17	00	235183	-	8 11 21	0 15	0 0 9	MAINZ
12	00	230170	-	8 11 38	0 10	0 0 9	FRIEDBERG
21	00	237173	-	8 12 6	0 16	0 0 21	DARMSTADT
19	00	230180	-	8 12 25	0 21	0 1 2	FRIEDBERG
17	00	233381	-	8 13 12	0 15	0 3 38	KIRCHGOENS
21	00	23646	=	8 13 47	0 15		FULDA
05	00	284267	-	8 14 14	0 20	0 0 8	VON ZWEBRCKN PBX
05	00	284261	-	8 14 45	0 14	0 0 1	VON ZWEBRCKN PBX
05	00	284261	-	8 15 4	0 12	0 0 1	VON ZWEBRCKN PBX
14	00	2846	=	8 15 18	0 6		INSUF DIGITS
14	00	284266	-	8 15 31	0 16	0 0 1	VON ZWEBRCKN PBX
05	00	284267	-	8 15 51	0 14	0 0 8	VON ZWEBRCKN PBX
03	00	284266	-	8 16 15	0 15	0 0 2	VON ZWEBRCKN PBX
05	00	281	=	8 16 34	0 5		MISDIAL
21	00	23126	=	8 16 41	0 10		FRANKFURT HOSP
21	00	231176	-	8 16 53	0 14	0 3 47	FRANKFURT
17	00	23121	=	8 17 8	0 11		FRANKFURT HOSP
17	00	23121	=	8 17 21	0 12		FRANKFURT HOSP

INTERRUPTION STATUS CHARACTERS - '-' SEIZURE, '=' SUBSCRIBER RELEASE,
'(' VAM INTERRUPTION OF OBSERVATION, 'I' NC TERM ENTRY, '+' TECH INTERRUPTION

Figure B-6. VAM Time Sort Report Sample

Figure B-7 is a typical example of call dispositions summarized in matrix form. Using this form, one can obtain performance figures for a single trunk or a single disposition category as well as total statistics. Also included are average holding time, average dialing time (for completed calls only), and average dialing time (for all calls) figures.

Figure B-8 is the holding time distribution associated with the study of Figure B-7. This distribution is broken into intervals of five seconds up to four minutes, the period between four and five minutes, the five-minute period from five to ten minutes and everything over ten minutes. Figures are given both as raw percentages and as cumulative percentages.

Because of the method by which the VAM determines that a call is complete, "holding time" as indicated in Figure B-8 is very likely not the holding time in the true sense. This is so because even after the VAM stops recording dialed digits, the calling party is very likely still dialing several more digits (if the VAM is set for less than the total number of digits, as almost always is the case). Based on consultations with 5th Signal Command personnel, a method of computing a probable interval to account for the extra dialed digits and also ringing time was devised. This weighting factor is included as the legend which is present in Figure B-8.

Because the DDD PBXs handle both AUTOVON and non-AUTOVON access calls, it is useful from the standpoint of the traffic flow study to further separate the statistics along these lines. Therefore, in actuality the statistical summary program generates three sets of call disposition/holding time charts: DDD calls, VON calls, and ALL calls (combined statistics — Figures B-7 and B-8 are in this combined category).

As a quick index to possible traffic patterns present during study period, a breakdown of phone calls based on called numbers is generated by the statistics program. This table provides, for all phone numbers to which at least one attempted call was made and recorded, the total number of times attempts to that number were made, the total number of times that calls were completed, and the percentage of the total number of calls attempted which were placed to that number. In addition, for both insufficient digits and misdialed call entries, the total number of calls and the percentage of the total number of attempts are listed. Figure B-9 illustrates the called number summary report. Figure B-10 is a block diagram representation of the complete VAM data reduction operation.

The statistical summary reports generated from the VAM call data are quite useful in determining the duration, disposition, and destination of calls placed through the switching equipment being monitored. Caution should be exercised, however, against making too strict an interpretation of the summaries, for the operation of the VAM equipment under certain conditions yields misleading re-

GIESSEN CLASS A1 & A2
ALL CALLS

CALL DISPOSITION	TRUNK 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
COMPLETED CALLS(-)	3	20	192	378	194	50	0	0	0	36	12	341	0
SUBSCR RELEASE(=)	5	43	371	207	189	60	0	0	0	31	9	197	0
VAM INTERRUPTION(()	0	0	15	16	6	2	0	0	0	1	0	9	0
TECH INTERRUPTION(+)	0	0	0	2	0	0	0	0	0	C	0	1	0
NO. OF. PULSES.GT.10(*)	0	C	0	C	0	0	0	0	0	C	0	0	0
NO TERM ENTRY(I)	0	0	0	1	0	0	0	0	0	C	0	1	0
TOTALS	8	63	578	604	389	112	C	0	0	68	21	549	0
AVERAGE HOLDING TIME	28	80	68	154	95	97	0	0	0	122	70	101	0
AVE DIAL TIME(COMP)	12	14	14	14	15	14	0	0	0	14	13	14	0
AVE DIAL TIME(ATT)	8	11	13	13	13	12	C	0	0	12	12	14	0

CALL DISPOSITION	TRUNK 13	14	15	16	17	18	19	20	21	22	23	24	TOTAL
COMPLETED CALLS(-)	126	79	6	C	111	2	286	10	117	C	10	303	2276
SUBSCR RELEASE(=)	120	66	8	0	85	5	162	17	114	C	8	221	1918
VAM INTERRUPTION(()	3	C	1	0	1	2	6	3	6	C	0	13	84
TECH INTERRUPTION(+)	0	0	0	C	0	0	1	0	0	C	0	0	4
NO. OF. PULSES.GT.10(*)	0	0	0	0	0	0	0	0	0	0	0	0	0
NO TERM ENTRY(I)	0	0	0	C	0	0	0	0	0	C	0	0	2
TOTALS	249	145	15	C	197	9	455	30	237	C	18	537	4284
AVERAGE HOLDING TIME	91	107	71	C	128	62	124	387	112	C	102	96	111
AVE DIAL TIME(COMP)	14	15	14	0	14	12	14	20	15	C	12	15	14
AVE DIAL TIME(ATT)	13	13	13	0	13	20	13	18	14	C	13	14	13

Figure B-7. VAM Call Disposition Report Summary

GIESSEN CLASS A1 & A2
ALL CALLS
HOLDING TIME DISTRIBUTION
(PERCENTAGE OF 2276)

INTERVAL (SECONDS)	PERCENT OCCURENCE	CUMULATIVE OCCURENCE
0 TO 5	5.14	5.14
5 TO 10	19.60	24.74
10 TO 15	13.66	38.40
15 TO 20	2.59	40.99
20 TO 25	2.94	43.94
25 TO 30	2.99	46.92
30 TO 35	3.12	50.04
35 TO 40	3.08	53.12
40 TO 45	1.89	55.01
45 TO 50	2.64	57.64
50 TO 55	2.28	59.93
55 TO 60	1.36	61.29
60 TO 65	2.20	63.49
65 TO 70	1.63	65.11
70 TO 75	1.80	66.92
75 TO 80	1.76	68.67
80 TO 85	1.19	69.86
85 TO 90	1.10	70.96
90 TO 95	1.01	71.97
95 TO 100	1.05	73.02
100 TO 105	0.88	73.90
105 TO 110	0.70	74.60
110 TO 115	0.66	75.26
115 TO 120	1.01	76.27
120 TO 125	0.75	77.02
125 TO 130	0.88	77.90
130 TO 135	0.53	78.43
135 TO 140	0.79	79.22
140 TO 145	0.57	79.79
145 TO 150	0.92	80.71
150 TO 155	0.66	81.37
155 TO 160	0.35	81.72
160 TO 165	0.26	81.99
165 TO 170	0.35	82.34
170 TO 175	0.53	82.86
175 TO 180	0.44	83.30
180 TO 185	0.44	83.74
185 TO 190	0.31	84.05
190 TO 195	0.40	84.45
195 TO 200	0.57	85.02
200 TO 205	0.57	85.59
205 TO 210	0.35	85.94
210 TO 215	0.35	86.29
215 TO 220	0.35	86.64
220 TO 225	0.22	86.86
225 TO 230	0.26	87.13
230 TO 235	0.13	87.26
235 TO 240	0.35	87.61
240 TO 300	2.90	90.51
300 TO 600	6.81	97.32
600 TO ***	2.68	100.00

DIALING COMPLETED AT ABOUT 4.4 SECONDS

FIRST RING OCCURS AT ABOUT 14.4 SECONDS

2ND RING OCCURS AT ABOUT 24.4 SECONDS
CALLS GREATER THAN 25 SECONDS MAY
REASONABLY BE CONSIDERED COMPLETE

Figure B-8. VAM Holding Time Distribution Report Summary

PHONE DIGITS	GIESSEN CLASS A1 & A2 NUMBER IDENTIFIER	TIMES CALLED	CALLS COMPL	PERCENT OF 4284 ATTEMPTS
2121XXXX	HEIDELBERG HDG	132	53	3.08
2122XXXX	HEIDELBERG HOSP	7	3	0.16
2131XXXX	MANNHEIM	114	38	2.66
2134XXXX	MONARCH CENTAG	4	3	0.09
2136XXXX	RHEINAU	121	35	2.82
2137XXXX	COLEMAN BKS	20	7	0.47
2141XXXX	KARLSRUHE	62	21	1.45
2142XXXX	ETTINGEN	1	0	0.02
2163XXXX	GERMERSHEIM	1	1	0.02
2211XXXX	PIRMASENS	12	10	0.28
2212XXXX	FISCHBACH	43	12	1.00
2221XXXX	KAISERSLAUTERN	37	14	0.86
2222XXXX	MIESAU	4	1	0.09
2223XXXX	LANDSTUHL MEDCTR	2	0	0.05
2226XXXX	VOGELWEH	1	0	0.02
2228XXXX	RAMSTEIN	4	1	0.09
2231XXXX	BAUMHOLDER	17	4	0.40
2233XXXX	PRUEM	1	0	0.02
2235XXXX	IDAR OBERSTEIN	2	1	0.05
2252XXXX	BAD KREUZNACH	10	4	0.23
2261XXXX	ZWEIBRUECKEN	38	11	0.89
2301XXXX	FRIEDBERG	388	201	9.06
2304XXXX	ROEDELHEIM	7	6	0.16
2305XXXX	RHEIN MAIN AIR B	65	45	1.52
2306XXXX	ESCHBORN	14	6	0.33
2307XXXX	GUTLEUT KASERNE	6	0	0.14
2309XXXX	HU/FLIEGERHORST	102	71	2.38
2310XXXX	AM CON GEN FKT	7	3	0.16
2311XXXX	FRANKFURT	398	330	9.29
2312XXXX	FRANKFURT HOSP	307	110	7.17
2313XXXX	OBERURSEL	11	8	0.26
2314XXXX	DRAKE KASERNE	124	70	2.89
2315XXXX	HOECHST	11	9	0.26
2317XXXX	ASCHAFFENBURG	8	7	0.19
2318XXXX	WIESBADEN	64	21	1.49
2319XXXX	MEHLEM LS EMB	4	0	0.09
2321XXXX	WUERZBURG	18	13	0.42
2322XXXX	WERTHEIM	2	0	0.05
2323XXXX	SCHWEINFURT	72	3[illegible]	1.68
2324XXXX	RIVER(WUERZBURG)	1	0	0.02
2325XXXX	KITZINGEN	2	1	0.05
2326XXXX	WUERZBURG HOSP	4	2	0.09
2328XXXX	BAD KISSINGEN	4	4	0.09
2331XXXX	GIESSEN	22	7	0.51
2333XXXX	KIRCHGOENS	207	196	4.83

Figure B-9. VAM Called Number Summary Report (Page 1 of 3)

GIESSEN CLASS A1 & A2

PHONE DIGITS	NUMBER IDENTIFIER	TIMES CALLED	CALLS COMPL	PERCENT OF 4284 ATTEMPTS
2327XXXX	BUTZBACH	252	239	5.88
2351XXXX	MAINZ	152	86	3.55
2353XXXX	WACKERNHEIM	3	2	0.07
2354XXXX	FINTHEN	1	1	0.02
2361XXXX	GELNHAUSEN	8	0	0.19
2363XXXX	BAD HERSFELD	84	40	1.96
2364XXXX	FULDA	194	80	4.53
2365XXXX	WILDFLECKEN	195	32	4.55
2371XXXX	DARMSTADT	120	70	2.80
2373XXXX	BABENHAUSEN	3	3	0.07
2376XXXX	DARMSTADT AIR SP	2	0	0.05
23767XXX	STARS&STRIPES	2	2	0.05
238XXXXX	BERLIN	2	1	0.05
2421XXXX	WORMS(USTASCOM)	8	4	0.19
2521XXXX	MUNICH	6	3	0.14
2531XXXX	BAD TOELZ	10	1	0.23
2535XXXX	GARMISCH	2	0	0.05
2538XXXX	BERCHTESGADEN	11	3	0.26
2581XXXX	AUGSBURG	17	11	0.40
2621XXXX	NUERNBERG	13	12	0.30
2622XXXX	NUERNBERG HOSP	6	6	0.14
2623XXXX	PINDER BKS	13	13	0.30
2624XXXX	MONTEITH BKS	4	4	0.09
2631XXXX	ERLANGEN	8	7	0.19
2633XXXX	ILLESHEIM	2	1	0.05
2636XXXX	SCHWABACH	3	0	0.07
2641XXXX	VILSECK	6	2	0.14
2643XXXX	GRAFENWOEHR	132	74	3.08
26430XXX	GRAFENWOEHR SWBD	41	15	0.96
2652XXXX	BAMBERG	6	5	0.14
2671XXXX	ANSBACH/HINDENBG	4	2	0.09
2721XXXX	STUTTGART	5	5	0.12
2723XXXX	KELLEY/STUTTGART	8	4	0.19
2725XXXX	BOEBLINGEN	8	5	0.19
2726XXXX	LUDWIGSBURG	5	2	0.12
2761XXXX	HEILBRONN	62	25	1.45
2762XXXX	NECKARSULM	3	2	0.07
28231XXX	VCN HIN 4W SUB	1	0	0.02
28424XXX	VCN RAMSTEIN PBX	1	1	0.02
28426XXX	VCN ZWEBRCKN PBX	15	15	0.35
28431XXX	VCN DCN 4W SUB	6	5	0.14
28433XXX	VCN KASRSLTN PBX	8	8	0.19
28434XXX	VCN MANNHEIM PBX	17	17	0.40
28435XXX	VCN HEIDLBRG PBX	8	8	0.19
28441XXX	VON FEL 4W SUB	1	1	0.02

Figure B-9. VAM Called Number Summary Report (Page 2 of 3)

GIESSEN CLASS A1 & A2

PHONE DIGITS	NUMBER IDENTIFIER	TIMES CALLED	CALLS COMPL	PERCENT OF 4284 ATTEMPTS
28443XXX	VCN BREMRHVN PBX	22	21	0.51
28444XXX	VCN FRANKFRT PBX	4	4	0.09
28455XXX	VCN BITBURG PBX	12	12	0.28
28482XXX	VCN RAMSTEIN	18	18	0.42
28488XXX	VCN RAMSTEIN	5	5	0.12
2921XXXX	PATCH(USEDCOM)VN	4	2	0.09
20XXXXXX	OPERATOR	18	0	0.42
	INSUFFICIENT DIGITS	115		2.68
	MISDIALED CALLS	147		3.43

Figure B-9. VAM Called Number Summary Report (Page 3 of 3)

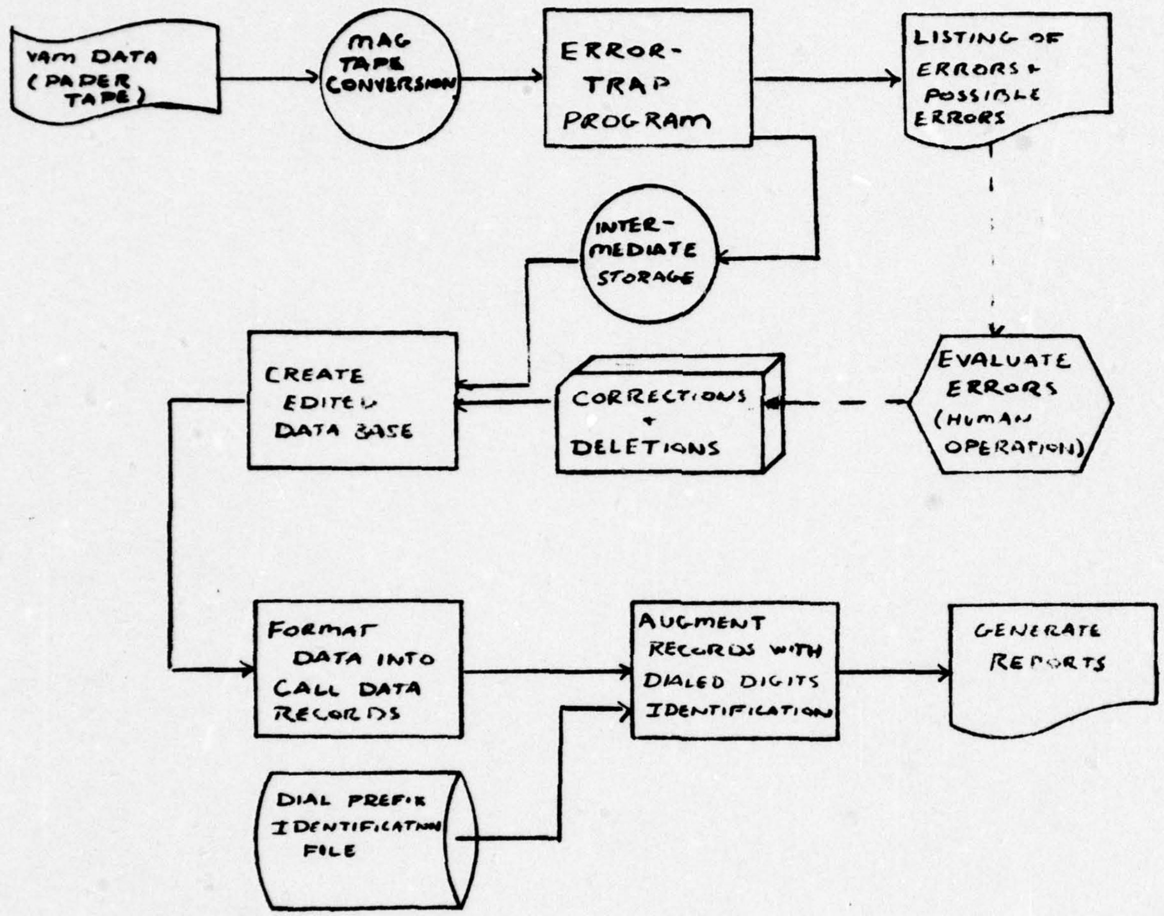


Figure B-10. VAM Data Reduction Process Block Diagram

sults. The impossibility of determining exact holding times, as discussed earlier, is one such situation. Another problematic situation exists in that short phone numbers (such as operator and special service numbers) are not seen as completed by the VAM equipment. This situation arises because the VAM does not mark a call complete (and, subsequently, look for a release time) unless the minimum number of dialed digits is received. Thus, operator calls, for example, are never seen to be complete. The net effect is to make the data look as though the grade of service is somewhat poorer than it really is.

A third, and highly non-obvious, characteristic of the VAM equipment which results in misleading data has to do with the intermittent misreading of an on-hook signal as a dialed digit "1". If, for some reason, the dialing party hangs up the instrument before the VAM has seen the required number of digits, the VAM may (but not always) interpret the on-hook supervision as a final dialed "1". This "1" may very likely be placed such that the called party identification is different from what it would be if the "1" were not recorded, resulting in erroneous called party statistics.

Finally, the method by which the VAM locks onto trunks creates a bias in the data base. If the trunk onto which the VAM is locked is released and quickly reseized, the VAM will once again lock into that trunk. Add to this the fact that due to the heavily congested nature of the DDD itself, a quick on-hook then off-hook is very likely to reseize the same trunk at the DCO. The combination results in a significant probability that subsequent release-reseizures will cause the VAM to lock into the reattempts in a way that biases the data base in terms of attempted called number statistics (see Figure B-11). Because this trunk-lockup phenomenon will only occur on incomplete calls (a completed call will release the VAM to scan other trunks before the call terminates), one can speculate that the data base is also biased toward incomplete call entries, making the grade of service calculations seem worse than they really are.

No exact clarification of the aforementioned data ambiguities is possible at the data reduction end. It is possible, however, to make some interpretational assumptions: for instance, assume that half (or all) of the operator calls are actually completed for purposes of grade of service calculations. At present, such assumptions are not implicit in the data reduction program employed by GTE Sylvania, on the theory that the assumptions should be explicitly applied to insure that the user is aware that assumptions are being made.

KAISERSLAUTERN -TRUNK SORT PAGE 26

TRK NO.	DAY	DIALED DIGITS	I S C	OFF-HOOK TIME H M S	DIAL TIME M S	HOLDING TIME H M S	DIALED DIGITS IDENTIFIER
07	02	213761	I	12 44 25	0 10		COLEMAN BKS
07	02	212162	-	12 45 41	0 9	0 1 37	HEIDELBERG HDG
07	02	221162	-	12 50 17	0 3	0 0 7	PIRMASENS
07	02	26388	=	12 56 16	0 19		KATTERBACH
07	02	284547	-	12 59 42	0 14	0 0 15	VON SPNGDHLM PBX
07	02	23178	=	13 3 19	0 7		ASCHAFFENBURG
07	02	23178	=	13 3 39	0 6		ASCHAFFENBURG
07	02	23178	=	13 3 52	0 6		ASCHAFFENBURG
07	02	23178	=	13 3 59	0 6		ASCHAFFENBURG
07	02	23178	=	13 4 6	0 6		ASCHAFFENBURG
07	02	23178	=	13 4 13	0 20		ASCHAFFENBURG
07	02	23178	=	13 4 34	0 7		ASCHAFFENBURG
07	02	23178	=	13 4 41	0 7		ASCHAFFENBURG
07	02	23178	=	13 4 48	0 7		ASCHAFFENBURG
07	02	23178	=	13 4 56	0 7		ASCHAFFENBURG
07	02	23178	=	13 5 4	0 8		ASCHAFFENBURG
07	02	23178	=	13 5 21	0 8		ASCHAFFENBURG
07	02	23178	=	13 5 44	0 7		ASCHAFFENBURG
07	02	23178	=	13 5 52	0 7		ASCHAFFENBURG
07	02	23178	=	13 5 59	0 7		ASCHAFFENBURG
07	02	23178	=	13 6 40	0 7		ASCHAFFENBURG
07	02	23178	=	13 6 48	0 6		ASCHAFFENBURG
07	02	23178	=	13 6 55	0 6		ASCHAFFENBURG
07	02	23178	=	13 7 2	0 8		ASCHAFFENBURG
07	02	23178	=	13 7 11	0 7		ASCHAFFENBURG
07	02	23178	=	13 7 18	0 7		ASCHAFFENBURG
07	02	23178	=	13 7 26	0 7		ASCHAFFENBURG
07	02	23178	=	13 7 40	0 7		ASCHAFFENBURG
07	02	212179	-	13 10 57	0 9	0 0 9	HEIDELBERG HDG
07	02	212168	-	13 11 19	0 15	0 0 33	HEIDELBERG HDG
07	02	212179	-	13 12 11	0 10	0 0 18	HEIDELBERG HDG
07	02	212168	-	13 12 42	0 10	0 0 25	HEIDELBERG HDG
07	02	212179	-	13 13 25	0 10	0 3 11	HEIDELBERG HDG
07	02	212169	-	13 16 48	0 9	0 0 11	HEIDELBERG HDG
07	02	212169	-	13 17 10	0 9	0 0 39	HEIDELBERG HDG
07	02	228	=	13 18 20	0 2		INSUF DIGITS
07	02	273271	-	13 19 53	0 16	0 0 48	SCHWAEBISCH GMUD
07	02	22218	=	13 21 16	0 6		KAISERSLAUTERN
07	02	212184	-	13 21 43	0 8	0 6 34	HEIDELBERG HDG
07	02	2318	=	13 28 29	0 4		INSUF DIGITS
07	02	23118	=	13 28 35	0 7		FRANKFURT
07	02	213792	-	13 28 48	0 12	0 0 4	COLEMAN BKS
07	02	2318	=	13 29 26	0 5		INSUF DIGITS
07	02	284277	-	13 29 51	0 10	0 0 8	VON SEMBACH PBX
07	02	21418	=	13 30 10	0 10		KARLSRUHE
07	02	213792	-	13 30 41	0 13	0 0 5	COLEMAN BKS

INTERRUPTION STATUS CHARACTERS - '-' SEIZURE, '=' SUBSCRIBER RELEASE,
'(' VAM INTERRUPTION OF OBSERVATION, 'I' NO TERM ENTRY, '+' TECH INTERRUPTION

Figure B-11. VAM Trunk Sort Sample

Appendix C
U.S. Air Force Base-to-Force Element Category — by Base Matrices

ALCONBURY	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY									.03		.03
ANKARA											
ATHENS				.02			.02		.05	.03	
AVIANO						.02			.12		.03
BENTWATERS	.02	.26	.17	.60	.56		.05		2.21	.22	.98
BERLIN											
BITBURG			.02	.12	.09		.10		.44		.21
BOTLEY HILL											
CHICKSANDS									4.91		.12
CROUGHTON							.10		1.06		1.31
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN	.02	.07	.09	.02	.02				.29	.10	.15
HILLINGDON							.05				.38
H. WYCOMBE									.87	.65	2.12
HUMOSA											.09
INCIPLIK											.12
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH	.09	.24	.97	1.32	1.30	1.98	.02	.02	3.90	.29	1.66
LINDSEY									1.49		1.27
LANGERKOPF							.02				.15
MAM-HEATH							.28				.06
MILDENHALL	1.30		.03	1.03	1.83	.05	.17	.07	2.65	2.02	1.27
MORON											
MT. FRANCA											
MT. LIMBARI							.02				
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	6.12	.23	.14	.12	1.03	.10			2.17	.12	4.21
RHEIN MAIN		.26	.02	.12	.62			.02	.33		.65
ROME											
SCHOENFELD				.14	.07				.10		.03
SCULTHORPE											
SEMBACH	.19	.02	.02	.05					.41	.17	.38
SOESTERBERG										.12	
SPANGDAHLEM		.02	.03	.05	.09				.27		.05
SAN VITO											.02
TEMPELHOF									.03		
THULE											
TORREJON	.02	.02	.02	.02	.22	.07		.10	.24	.02	.21
U. HEYFORD	.26	.05	.34	.31	.94		.02		1.66	.19	2.14
WEATHERSFIELD									3.76		.53
WIESBADEN	.53				.07	.36	.07	.02		.43	.17
WOODBRIDGE											
ZARAGOZA	.02	.87	.89	.02	.03				.48	.03	.21
ZWEIBRUCKEN		.19	.24	.07	.14		.02		1.03		.02
ARMY										2.97	4.92
NAVY										.47	1.36
OTHER-EUR										4.15	.17
CONUS											.26

Figure C-1. USAF Base-to-Force Element Category-by Base (Alconbury)
(Percent of Originating AUTOVON Traffic)

AVIANO	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY									.32		.08
ANKARA											
ATHENS				.08		.08			.65	.08	.48
AVIANO											.08
BENTWATERS		.08	.08	.16					.32		.08
BERLIN										.08	
BITBURG			.24	.08		.08			.24		.16
BOTLEY HILL											
CHICKSANDS									.16		
CROUGHTON							.08				.16
DIYARBIKIR											
FELDBERG							.24				
FYLINGDALES											
HAHN			.08	.08	.08				.32		.16
HILLINGDON											
H. WYCOMBE									.08		.40
HUMOSA											.32
INCIPLIK									1.53		.89
IRAKLION											
IZMIR											
KARAMURSEL									.08		
KAPAUN BKS											
LAKENHEATH		.16	.16						.24		.16
LINDSEY									1.94		
LANGERKOPF							.08				.08
MAM-HEATH											.16
MILDENHALL			.08	.16					.48	.65	.24
MORON											.08
MT. FRANCA							.65				
MT. LIMBARI							1.78				
MT. PATERAS											
MT. REGGIO							1.29				
MT. VERGINE							4.68				.08
MUEHLZCH											
PRUEM											
RAMSTEIN	3.63	1.86	4.68	1.86	1.53	.16	.57	.08	2.66	.65	9.13
RHEIN MAIN		.73		.16	.08	.08	.57		1.29	.08	1.37
ROME				.08						.24	
SCHOENFELD											
SCULTHORPE											
SEMBACH									.16	.16	.24
SOESTERBERG											
SPANGDAHLEM	.08	.08	.08	.08					.16		.16
SAN VITO									1.78		.08
TEMPELHOF									.08		
THULE											
TORREJON	.40	.89	1.37	.89	.73	.16	.24		3.96	1.13	2.02
U. HEYFORD			.08	.40			.08		.16		
WEATHERSFIELD											
WIESBADEN	.32			.08	.08	.73		.08		.48	.57
WOODBRIDGE											
ZARAGOZA	.08	.40	.24	.24					1.29	.24	.48
ZWEIBRUCKEN				.08					.24		.08
ARMY										6.22	12.84
NAVY										1.70	1.62
OTHER-EUR											2.18
CONUS											.67

Figure C-1. USAF Base-to-Force Element Category-by Base (Aviano)
(Percent of Originating AUTOVON Traffic)

BENTWATERS	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY		.09	.09	1.51	.09				2.04		.27
ANKARA											
ATHENS									.18		
AVIANO					.09				.27		
BENTWATERS											.09
BERLIN					.09						
BITBURG				.44	.09				.35		1.24
BOTLEY HILL											
CHICKSANDS									1.24		.09
CROUGHTON							.09		1.06		.18
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN			.53	.44	.09				.35		.44
HILLINGDON											.09
H. WYCOMBE									.80	.53	
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL									.09		.09
KAPAUN BKS											
LAKENHEATH		.18	.71	2.13	1.06	2.31	.09		5.24	.80	2.13
LINDSEY									1.24		.09
LANGERKOPF							.71				.09
MAM-HEATH											
MILDENHALL	1.24	.27	.18	.89	2.40	.09			4.17	2.31	1.24
MORON											
MT. FRANCA											
MT. LIMBARI							.18				
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	7.45	.09	.18	.80	.80		.44		5.50	.09	7.01
RHEIN MAIN		.53		.53	.44		.18	.09	2.04	.18	1.51
ROME											
SCHOENFELD											
SCULTHORPE											.09
SEMBACH	.18			1.06	.09				1.51	.35	.18
SOESTERBERG											
SPANGDAHLEM			.09	.27	.09				.71		.89
SAN VITO											
TEMPELHOF											
THULE											
TORREJON				.27			.09		.89		.18
U. HEYFORD	.09		.27	.62	.18				1.42		.80
WEATHERSFIELD									.98		
WIESBADEN	1.24				.09		.44			.53	.27
WOODBRIDGE											
ZARAGOZA			.27	.62					.98	.27	.09
ZWEIBRUCKEN			.09	.18					.62	.09	.35
ARMY										1.77	6.04
NAVY										1.86	1.60
OTHER-EUR										.44	.35
CONUS											.27

Figure C-1. USAF Base-to-Force Element Category-by Base (Bentwaters)
(Percent of Originating AUTOVON Traffic)

BITBURG	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY					.91						
ANKARA						.45					
ATHENS											
AVIANO			.15	.15					.15		
BENTWATERS									.30		
BERLIN									.30		
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN		.30	.76		1.66				4.08	.45	
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK									.76		
IRAKLION											
IZMIR											
KARAMURSEL									1.51		
KAPAUN BKS											
LAKENHEATH			.30	.61		.15			.30		.15
LINDSEY									5.14		
LANGERKOPF											
MAM-HEATH											
MILDENHALL									.15		.15
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	4.23	.76	.45	.30	2.12	.30			4.39		1.82
RHEIN MAIN		.45		1.36			2.72		1.66	.15	
ROME											
SCHOENFELD							1.06				.30
SCULTHORPE											.45
SEMBACH	.45								.45	.30	2.88
SOESTERBERG											
SPANGDAHLEM					1.06		.15		.45		
SAN VITO									.76		
TEMPELHOF									.91		
THULE											
TORREJON					.30	.15			.30		
U. HEYFORD		.15			1.36				1.36		
WEATHERSFIELD											
WIESBADEN	1.51					1.21	.15			1.36	
WOODBRIDGE											
ZARAGOZA			.45					.45			.30
ZWEIBRUCKEN			.15	.30	.15			.45	.45		1.07
ARMY	.30									29.80	3.94
NAVY										.15	
OTHER-EUR								.15			.45
CONUS											4.39

Figure C-1. USAF Base-to-Force Element Category-by Base (Bitburg)
(Percent of Originating AUTOVON Traffic)

CHICKSANDS	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO											
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON							7.69				
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON							7.69				
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											15.38
MAM-HEATH											7.69
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN									7.69		
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										7.69	30.77
NAVY											
OTHER-EUR											15.39
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (Chicksands)
(Percent of Originating AUTOVON Traffic)

CROUGHTON	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY									1.98		
ANKARA											
ATHENS							.49		.16		.16
AVIANO											.16
BENTWATERS			.16						3.62		
BERLIN							.33			.33	.33
BITBURG									.33		
BOTLEY HILL											
CHICKSANDS									.82	.16	
CROUGHTON							.16		.49		.49
DIYARBIKIR											
FELDBERG							.16				
FYLINGDALES							.33				
HAHN							2.3			.33	
HILLINGDON					.16				2.80		1.97
H. WYCOMBE											
HUMOSA									1.48		.16
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH									.99		.66
LINDSEY							.16		.82		.33
LANGERKOPF											
MAM-HEATH							1.48				1.31
MILDENHALL		.33					.33	.33	3.46	1.48	1.15
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS							.49				
MT. REGGIO											
MT. VERGINE							.66				
MUEHLZCH											
PRUEM											
RAMSTEIN	.66						2.14	.33	5.93	.49	.98
RHEIN MAIN									2.80		.82
ROME											
SCHOENFELD											
SCULTHORPE									.49		
SEMBACH									.16		.33
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON							.16		.49		
U. HEYFORD		.16							.49		
WEATHERSFIELD									1.65		.16
WIESBADEN				.16			.33				
WOODBRIDGE											
ZARAGOZA		.33							.33		
ZWEIBRUCKEN							.16				
ARMY										13.12	2.97
NAVY							.33				5.42
OTHER-EUR											4.43
CONUS											18.42

Figure C-1. USAF Base-to-Force Element Category-by Base (Croughton)
(Percent of Originating AUTOVON Traffic)

FELDBURG	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO									2.64		
BENTWATERS											
BERLIN										2.85	.41
BITBURG									1.01		
BOTLEY HILL											
CHICKSANDS											
CROUGHTON							.20				
DIYARBIKIR											
FELDBERG							.41				.41
FYLINGDALES											
HAHN							.20		.41	.41	
HILLINGDON							2.03				
H. WYCOMBE											
HUMOSA							.61				
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY							.61				
LANGERKOPF							7.52				1.42
MAN-HEATH							1.02				
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI							.41				
MT. PATERAS											
MT. REGGIO											
MT. VERGINE							2.64				
MUEHLZCH											
PRUEM											
RAMSTEIN							1.02		1.02	1.02	4.66
RHEIN MAIN		.2		.81	3.25	.2	4.89		.41	.81	2.23
ROME											
SCHOENFELD							2.44				
SCULTHORPE											
SEMBACH									1.63		
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF									.41		
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN							.2				
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										16.66	13.83
NAVY											
OTHER-EUR										.61	5.49
CONUS											14.84

Figure C-1. USAF Base-to-Force Element Category-by Base (Feldburg)
(Percent of Originating AUTOVON Traffic)

FYLINGDALES	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY									4.76		
ANKARA											
ATHENS											
AVIANO											
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											
MAM-HEATH							4.76				
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN											
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										9.52	
NAVY										4.76	
OTHER-EUR											
CONUS											76.19

Figure C-1. USAF Base-to-Force Element Category-by Base (Hahn)
(Percent of Originating AUTOVON Traffic)

HAHN	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY				.12	.09			.06	.73	.06	.12
ANKARA										.03	.12
ATHENS					.06				.55	.09	
AVIANO				.06					.24		.12
BENTWATERS			.45	.24	.06		.06		.45	.39	.36
BERLIN					.09		.27		.03	.06	.09
BITBURG	.03	.15	.73	1.54	.42	.12	.09	.88	.94	.39	1.54
BOTLEY HILL											
CHICKSANDS									.48		
CROUGHTON									.09		.12
DIYARBIKIR											
FELDBERG							.15				.09
FYLINGDALES											
HAHN							.03		.12		.27
HILLINGDON											
H. WYCOMBE									.06		.09
HUMOSA											.18
INCIPLIK									.33		.48
IRAKLION											
IZMIR											
KARAMURSEL									.15		.06
KAPAUN BKS											
LAKENHEATH		.30	.27	.60		.09			.60		.30
LINDSEY									1.12		
LANGERKOPF							.12				.06
MAM-HEATH											.06
MILDENHALL					.06				.06		.15
MORON											.06
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS							.03				
MT. REGGIO											
MT. VERGINE											.06
MUEHLZCH											
PRUEM											
RAMSTEIN	.63	.06	.09	.09	.24	.06	.15	.09	2.12	.09	1.42
RHEIN MAIN											
ROME											
SCHOENFELD							1.73				.24
SCULTHORPE				.06					.15		
SEMBACH	.27	.06	.12	.27	.12	.09		.24	.36	.09	.82
SOESTERBERG											
SPANGDAHLEM	.06	.12	.91	.97	1.73	.15	.18	.03	2.24	1.88	3.12
SAN VITO									.03		.12
TEMPELHOF									.03		
THULE											
TORREJON			.27	.30					.55	.70	1.51
U. HEYFORD				.06					.12		.18
WEATHERSFIELD											.06
WIESBADEN	1.57			.09	.15	.39	.76	.15	1.09	.30	1.24
WOODBRIDGE											
ZARAGOZA	.06	4.97	3.73	1.61	.42	.30	.06		1.39	.67	1.51
ZWEIBRUCKEN		.12	.27	.91	.27				.76		.24
ARMY	.33									18.26	5.82
NAVY										.76	.69
OTHER-EUR										.82	.82
CONUS											19.47

Figure C-1. USAF Base-to-Force Element Category-by Base (Fylingdales) (Percent of Originating AUTOVON Traffic)

HILLINGDON	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO											
BENTWATERS							1				
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS									2		1
CROUGHTON							11		4		7
DIYARBIKIR											
FELDBERG							1				1
FYLINGDALES											
HAHN											
HILLINGDON							1				1
H. WYCOMBE					1				2		2
HUMOSA							1				1
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											6
MAM-HEATH							1				
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS							1				
MT. REGGIO											
MT. VERGINE							1				
MUEHLZCH											
PRUEM											
RAMSTEIN											
RHEIN MAIN			3								
ROME											
SCHOENFELD							4				
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD				2					2		1
WEATHERSFIELD											
WIESBADEN							1				1
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										4	
NAVY										5	
OTHER-EUR											21
CONUS											8

Figure C-1. USAF Base-to-Force Element Category-by Base (Hillingdon)
(Percent of Originating AUTOVON Traffic)

HIGH WYCOMBE	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY		.19			.19				2.32	.19	.19
ANKARA											
ATHENS										.58	
AVIANO											
BENTWATERS				.19	.39		.19		2.90	.39	1.36
BERLIN											
BITBURG										.19	.39
BOTLEY HILL											
CHICKSANDS									1.74		
CROUGHTON							.77		1.74		7.93
DIYARBIKIR											
FELDBERG											.19
FYLINGDALES											
HAHN					.19				.19		
HILLINGDON											.58
H. WYCOMBE											1.74
HUMOSA											
INCIPLIK									.19		
IRAKLION											
IZMIR											
KARAMURSEL									.19		
KAPAUN BKS											
LAKENHEATH				.39	1.16	.77	.19		2.51	.58	1.36
LINDSEY									.19		
LANGERKOPF											
MAM-HEATH											
MILDENHALL	1.55			.19	.77				1.35	1.16	.39
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	1.74			.39	2.51		.19		.58	.19	2.51
RHEIN MAIN							.19		.38	1.55	.96
ROME											
SCHOENFELD											
SCULTHORPE							.19				
SEMBACH											.39
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON									.19		
U. HEYFORD	1.55	.58	.19	5.80	7.16	.19	.19		7.54	.58	5.42
WEATHERSFIELD									1.55		.19
WIESBADEN										.19	
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										8.70	4.26
NAVY										2.71	2.71
OTHER-EUR										.58	3.09
CONUS											0

Figure C-1. USAF Base-to-Force Element Category-by Base (High Wycombe)
(Percent of Originating AUTOVON Traffic)

HUMOSA	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO											
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON							11.11				
H. WYCOMBE											
HUMOSA							13.89				25.0
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											
MAN-HEATH							2.78				
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE							5.56				
MUEHLZCH											
PRUEM											
RAMSTEIN											
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON									5.56		
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										5.56	16.67
NAVY											5.56
OTHER-EUR											8.33
CONUS											0

Figure C-1. USAF Base-to-Force Element Category-by Base (Humosa)
(Percent of Originating AUTOVON Traffic)

KAPAUNBK	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY								18.6			
ANKARA											
ATHENS								2.33			
AVIANO											
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON									9.33		4.65
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											2.33
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											
MAM-HEATH											
MILDENHALL								13.95			
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	2.33										
RHEIN MAIN								11.63			6.98
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON								9.3			
U. HEYFORD									6.98		
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA								2.33			
ZWEIBRUCKEN											
ARMY											6.98
NAVY											
OTHER-EUR											
CONUS											2.33

Figure C-1. USAF Base-to-Base Element Category-by Base (Kapaunbk)
(Percent of Originating AUTOVON Traffic)

LAKENHEATH	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY	.07	.15	.60	.07	.37	.15			4.33	.07	.52
ANKARA											
ATHENS				.07					.07		
AVIANO									.37		
BENTWATERS		.82	.52	1.19	.52		.15		5.22		3.28
BERLIN										.22	.22
BITBURG				.07	.07					.15	.15
BOTLEY HILL											
CHICKSANDS								2.31			
CROUGHTON								.45			.07
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN			.07					.22			.82
HILLINGDON											.07
H. WYCOMBE								.82	1.27		.90
HUMOSA											
INCIPLIK								.22			.60
IRAKLION											
IZMIR											
KARAMURSEL								.07			
KAPAUN BKS											
LAKENHEATH								.07			.15
LINDSEY								2.69			.52
LANGERKOPF											.30
MAM-HEATH											.07
MILDENHALL			.07					.45			.07
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	10.45	.07		.75	1.49		.07		1.79	.22	5.15
RHEIN MAIN		.07		.52			.22		.30	.37	1.79
ROME											
SCHOENFELD											.15
SCULTHORPE				1.04	.90		.37		.75		.37
SEMBACH											
SOESTERBERG				.07							.15
SPANGDAHLEM		.07	.37		.37				.45		.60
SAN VITO											
TEMPELHOF									3.21		
THULE											
TORREJON				.30	.07				.07		.30
U. HEYFORD	.30	1.27	1.57	1.19	.82	.37	.22		3.21	.52	3.21
WEATHERSFIELD									1.57		.30
WIESBADEN	.82				.15	.60				.67	.22
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN			.07				.15			.07	.30
ARMY										4.18	2.61
NAVY										4.40	2.02
OTHER-EUR											.52
CONUS											.07

Figure C-1. USAF Base-to-Force Element Category-by Base (Lakenheath)
(Percent of Originating AUTOVON Traffic)

LANGERKOPF	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO							.78				
BENTWATERS											
BERLIN											
BITBURG									.26		
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG							2.60				
FYLINGDALES											
HAHN											
HILLINGDON							.52				
H. WYCOMBE									.26		
HUMOSA							.52				
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY									.26		
LANGERKOPF							2.08				5.21
MAM-HEATH							.52				
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE							.26				
MUEHLZCH							.78				
PRUEM											
RAMSTEIN	.26	.26	.52	.52	3.02	.78	3.64		1.04	1.04	3.64
RHEIN MAIN			.26		.26		7.08		.52		
ROME											
SCHOENFELD							1.04				
SCULTHORPE											
SEMBACH							.52		.78		1.04
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN										.78	
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN							.52			.52	
ARMY										10.00	14.84
NAVY											
OTHER-EUR										.52	15.46
CONUS											.26

Figure C-1. USAF Base-to-Force Element Category-by Base (Langerkopf) (Percent of Originating AUTOVON Traffic)

LINDSEY	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY					.08				1.28		.24
ANKARA									.87		.39
ATHENS									.98		.22
AVIANO									2.18		.21
BENTWATERS											
BERLIN										.29	.17
BITBURG						.08			.95		.80
BOTLEY HILL											
CHICKSANDS											
CROUGHTON							.12		.33		.35
DIYARBIKIR											
FELDBERG											.57
FYLINGDALES											
HAHN									1.46		.47
HILLINGDON											.07
H. WYCOMBE									.17		.04
HUMOSA											.01
INCIPLIK									2.32		.64
IRAKLION									.81		.08
IZMIR											
KARAMURSEL									1.67		.10
KAPAUN BKS											
LAKENHEATH		.05			.31		.08		.69		.07
LINDSEY							.01		.03		
LANGERKOPF							.08				
MAM-HEATH											.04
MILDENHALL											
MORON							.01	.29	.07		.20
MT. FRANCA											.07
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											.04
MT. VERGINE											
MUEHLZCH											.07
PRUEM											
RAMSTEIN		.03			.17		.03		1.59	.66	.61
RHEIN MAIN									.01		.13
ROME										.03	
SCHOENFELD								.03			.13
SCULTHORPE											.03
SEMBACH									1.07		2.68
SOESTERBERG											
SPANGDAHLEM									.59		.45
SAN VITO											.05
TEMPELHOF									.21		
THULE											
TORREJON	.13	.07		.16	.01				1.50	.13	.70
U. HEYFORD		.03					.05		.35		.70
WEATHERSFIELD									.27		.13
WIESBADEN										.01	.08
WOODBRIDGE											
ZARAGOZA	.01	.03			.01				.25		.29
ZWEIBRUCKEN									.53	.72	.41
ARMY										18.12	28.75
NAVY										3.12	1.51
OTHER-EUR										1.69	3.69
CONUS											6.75

Figure C-1. USAF Base-to-Force Element Category-by Base (Lindsey)
(Percent of Originating AUTOVON Traffic)

McGUIRE	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA									.74		
ATHENS									2.21		.25
AVIANO									1.47		
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON							.98				
DIYARBIKIR											
FELDBERG											9.58
FYLINGDALES											
HAHN									.49		
HILLINGDON											
H. WYCOMBE											
HUMOSA											.49
INCIPLIK				2.46					3.44		
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											
MAM-HEATH											
MILDENHALL				1.23					3.93	1.23	.25
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	.49								15.23	13.76	1.72
RHEIN MAIN		.74		3.93			3.44		9.58		2.70
ROME				.49							
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON	.98			5.90					.98	1.72	
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA									.25		
ZWEIBRUCKEN											
ARMY											.49
NAVY										1.97	6.38
OTHER-EUR											.49
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (McGuire) (Percent of Originating AUTOVON Traffic)

MILDENHALL	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY	.10	.10	.20	.20	.40		.10		2.18	.20	.49
ANKARA									.10		.10
ATHENS			.20	.30					.10		
AVIANO				.20					.40		.20
BENTWATERS	.20	.10	.79	.30	.99	.10	.20		4.15	.49	2.18
BERLIN										.10	.30
BITBURG			.10						.20		.20
BOTLEY HILL											
CHICKSANDS									.89		.10
CROUGHTON							.49		.69		1.38
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN		.10			.40				.20		.10
HILLINGDON							.69				
H. WYCOMBE									1.19	.40	.79
HUMOSA											.49
INCIPLIK									.89		.89
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH									.30		
LINDSEY									.59		.49
LANGERKOPF											.49
MAM-HEATH											.20
MILDENHALL							.49				.20
MORON											.10
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											.20
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	6.53		.10	.89	1.18		.40		.40	.79	5.54
RHEIN MAIN	.40	1.58	.20	1.19	.79		.49	.10	.30	.20	2.77
ROME											
SCHOENFELD											.20
SCULTHORPE				.20					.20		.20
SEMBACH				.40					.30	.10	.20
SOESTERBERG											
SPANGDAHLEM				.10					.20		.10
SAN VITO									.10		
TEMPELHOF											
THULE											
TORREJON				.10	.20				.40	.79	
U. HEYFORD	.20	.49	.69	.69	.89		.49		2.27	.20	1.78
WEATHERSFIELD									.99		.20
WIESBADEN	.49							.10		.30	
WOODBRIDGE							.10				
ZARAGOZA		.10	.10						1.58		.59
ZWEIBRUCKEN			.10						.20	.20	.20
ARMY										2.47	.40
NAVY										3.46	.20
OTHER-EUR										.20	.30
CONUS											23.14

Figure C-1. USAF Base-to-Force Element Category-by Base (Mildenhall)
(Percent of Originating AUTOVON Traffic)

MORON	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA									.81		
ATHENS									.61		.40
AVIANO									2.22		
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON											
H. WYCOMBE											
HUMOSA							.61				
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY									1.01		
LANGERKOPF											
MAM-HEATH											
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	1.21								.61		
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON	1.61		1.21	10.08	11.90		2.82		7.66	4.44	9.49
U. HEYFORD			.20		.61						
WEATHERSFIELD											
WIESBADEN	.20				1.01						.40
WOODBRIDGE											
ZARAGOZA			.61	1.41	1.41				.40	4.03	1.22
ZWEIBRUCKEN										.20	3.83
ARMY										3.03	5.24
NAVY										3.03	20.49
OTHER-EUR											1.61
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (Moron)
(Percent of Originating AUTOVON Traffic)

MT. FRANCA.	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO							8.0		60.0		8.0
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIRLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY									8.0		
LANGERKOPF											
MAM-HEATH											
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE							4.0				4.0
MUEHLZCH											
PRUEM											
RAMSTEIN											
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY											
NAVY											
OTHER-EUR										4.0	
CONUS											0

Figure C-1. USAF Base-to-Force Element Category-by Base (Mt. Franca)
(Percent of Originating AUTOVON Traffic)

MT. LIMBARI	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO				3.85	13.46		2.88		26.92	1.92	13.46
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG							1.92				
FYLINGDALES											
HAHN											
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL									1.92		
KAPAUN BKS											
LAKENHEATH											
LINDSEY									3.85		
LANGERKOPF											
MAN-HEATH											
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO							3.85				
MT. VERGINE							1.92				
MUEHLZCH											
PRUEM											
RAMSTEIN									1.92		
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO									9.62		1.92
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY											
NAVY											
OTHER-EUR											
CONUS											1.92

Figure C-1. USAF Base-to-Force Element Category-by Base (Mt. Limbari)
(Percent of Originating AUTOVON Traffic)

MT. REGGIO	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO				2.60	5.20		1.30		27.27		5.19
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											
MAM-HEATH											
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE							9.09				3.90
MUEHLZCH											
PRUEM											
RAMSTEIN											
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO									18.18		
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY											
NAVY										27.27	
OTHER-EUR											
CONUS											0

Figure C-1. USAF Base-to-Force Element Category-by Base (Mt. Reggio)
(Percent of Originating AUTOVON Traffic)

MT. VERGINE	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA									1.05		
ATHENS											
AVIANO							5.24		24.09		4.71
BENTWATERS											
BERLIN											
BITBURG									.52	1.57	
BOTLEY HILL											
CHICKSANDS											
CROUGHTON							1.05				
DIYARBIKIR											
FELDBERG							1.05				.52
FYLINGDALES											
HAHN											
HILLINGDON							2.09				.52
H. WYCOMBE											
HUMOSA							1.57				
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL				.52							
KAPAUN BKS											
LAKENHEATH											
LINDSEY									2.09		
LANGERKOPF											.52
MAM-HEATH											.52
MILDENHALL											
MORON											
MT. FRANCA							1.05				
MT. LIMBARI											
MT. PATERAS							1.57				
MT. REGGIO							2.62				
MT. VERGINE							17.80				1.05
MUEHLZCH											
PRUEM											
RAMSTEIN											
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO									6.81		
TEMPELHOF											
THULE											
TORREJON							2.09		.52		
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY											2.09
NAVY											
OTHER-EUR											13.09
CONUS											5.24

Figure C-1. USAF Base-to-Force Element Category-by Base (Mt. Vergine)
(Percent of Originating AUTOVON Traffic)

MUEHLZCH	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO									2.50		5.0
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG							5.0				
FYLINGDALES											
HAHN											
HILLINGDON							2.50				
H. WYCOMBE									2.50		
HUMOSA											
INCIRLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY									2.50		
LANGERKOPF											2.5
MAM-HEATH							12.5				
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN							2.50		2.50		5.0
RHEIN MAIN				5.0			20.0		2.5		15.00
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											2.5
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN							7.5			2.5	
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY											
NAVY											
OTHER-EUR											
CONUS											0

Figure C-1. USAF Base-to-Force Element Category-by Base (Muhl)
(Percent of Originating AUTOVON Traffic)

PRUEM	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO											
BENTWATERS											
BERLIN											
BITBURG					7.04						7.04
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											4.23
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY									1.41		
LANGERKOPF											
MAM-HEATH											
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN											
RHEIN MAIN				1.41						11.26	
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH	9.86								7.04	1.41	36.62
SOESTERBERG											
SPANGDAHLEM											5.63
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											1.41
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										2.82	1.41
NAVY											
OTHER-EUR											
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (Pruem)
(Percent of Originating AUTOVON Traffic)

RAMSTEIN	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY	.13	.06	.15	.26	.09	.02			1.02	.05	.15
ANKARA									.49	.26	.34
ATHENS				.69	.43	.05	.01		1.68	.22	.36
AVIANO		.12	.06	.15	.44			.02	1.02	.36	.37
BENTWATERS	.20	.39	.49	.45	.54		.02		1.17	.04	.88
BERLIN				.09	.14	.01	.09			.45	.53
BITBURG	.01		.15	.10	.16	.01		.01	.25	.04	.30
BOTLEY HILL											
CHICKSANDS									.16		.01
CROUGHTON							.15		.06		.27
DIYARBIKIR									.04		
FELDBERG								.29			.25
FYLINGDALES											.14
HAHN	.05	.01	.07	.09	.11	.02	.02	.01	.70	.11	.17
HILLINGDON											.09
H. WYCOMBE					.01				.50	.01	.03
HUMOSA											.04
INCIPLIK				.77					1.84		1.63
IRAKLION									.22		.03
IZMIR											
KARAMURSEL									.36		.14
KAPAUN BKS											
LAKENHEATH	.10	.07	.43	.55	.39	.14	.02	.05	.87	.20	.61
LINDSEY							.10		1.57	.04	
LANGERKOPF							.41			.06	.79
MAM-HEATH							.18				.20
MILDENHALL	.59	.07	.28	.18	.48		.11	.01	.77	.74	.49
MORON					.01			.02			.03
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											.01
MT. REGGIO											
MT. VERGINE							.09				
MUEHLZCH							.22				
PRUEM											
RAMSTEIN	.01	1.09					.05		.20		.26
RHEIN MAIN	.04	.21	.04	.93	.34	.05	.25	.55	.22		.58
ROME											
SCHOENFELD							.11				.16
SCULTHORPE				.02	.02			.02			.02
SEMBACH	.27	.21	.21	.36	.43	.06	.05	.01	1.03	.16	1.36
SOESTERBERG										.01	
SPANGDAHLEM	.06	.04	.44	.09	.14			.01	.43		.34
SAN VITO						.02			.97		.08
TEMPELHOF									.47		
THULE											
TORREJON	.85	.07	.49	1.13	.82	.12	.05	.01	1.54	.98	1.98
U. HEYFORD	.11	.16	.33	.22	.61		.02	.01	1.28	.05	.99
WEATHERSFIELD									.11		.11
WIESBADEN	.07	.01			.01	.25	.12	.04		.15	.44
WOODBRIDGE											
ZARAGOZA	.27	.18	.56	.59	.34	.06	.04		.96	.15	.64
ZWEIBRUCKEN	.01	.21	.06	.16	.22		.06		.36	.17	.34
ARMY										12.58	7.58
NAVY										1.72	.74
OTHER-EUR										.64	3.74
CONUS											8.12

Figure C-1. USAF Base-to-Force Element Category-by Base (Ramstein)
(Percent of Originating AUTOVON Traffic)

RHEIN MAIN	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09. OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY								.04	.25		.07
ANKARA									.20	.03	.07
ATHENS				.07	.03	.08	.26		.77	.11	.18
AVIANO				.12	.05	.12	.09	.03	.69		.22
BENTWATERS		.01		.11	.09		.25	.21	.30		.16
BERLIN				.C1	.70		.08			.25	.53
BITBURG	.11	.01	.33	.33	.26	.05	.05	.11	2.69	.15	.58
BOTLEY HILL											
CHICKSANDS									.04		
CROUGHTON							.38		.21		.55
DIYARBIKIR									.09		
FELDBERG							.89				.10
FYLINGDALES											
HAHN	.03	.04	.29	.15	.19		.16	.30	.77	.16	.38
HILLINGDON							.01				.19
H. WYCOMBE									.22	.05	.15
HUMOSA											.69
INCIPLIK				.04					3.88		3.28
IRAKLION									.29		
IZMIR											
KARAMURSEL									.16		.17
KAPAUN BKS											
LAKENHEATH	.08	.01		.12	.04	.09		.11	.21		.15
LINDSEY							.03		1.81		
LANGERKOPF							.41		.07		.34
MAM-HEATH							.01				.03
MILDENHALL	.09	.07	.42	.52	.09		.08	.17	.89	1.23	.66
MORON											
MT. FRANCA											
MT. LIMBARI							.11				
MT. PATERAS											
MT. REGGIO											
MT. VERGINE							.01				.06
MUEHLZCH							.38				
PRUEM											
RAMSTEIN	.58	.52	.25	.01	.19		.31	.19	1.35	.30	.84
RHEIN MAIN							.03		.03	.01	.05
ROME									.07		
SCHOENFELD							.67				.06
SCULTHORPE											.01
SEMBACH	.26	.17	.11	.19	.56		.08		.47	.01	1.13
SOESTERBERG											
SPANGDAHLEM		.16	.16	.08	.25	.12	.08	.03	1.07	.07	.56
SAN VITO							.01		.46		.03
TEMPELHOF							.01		.52		
THULE											
TORREJON	.33	.12	.11	.43	.15	.08	.09	.05	.78	1.96	.37
U. HEYFORD	.05	.12	.03		.05		.08	.01	.28	.01	.30
WEATHERSFIELD									.01		.06
WIESBADEN	.08	.03		.02	.21	.25	.11	.09		.49	.67
WOODBRIDGE											
ZARAGOZA		.07	.15	.30		.03	.05	.04	.24		.12
ZWEIBRUCKEN		.03	.01	.03	.08	.01	.05	.01	.40	.09	.20
ARMY										16.25	10.09
NAVY		.49								2.70	1.06
OTHER-EUR										.38	3.03
CONUS											10.15

Figure C-1. USAF Base-to-Force Element Category-by Base (Rheim Main)
(Percent of Originating AUTOVON Taffic)

ROME	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS									1.75		
AVIANO					1.75				14.03		19.31
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON											
H. WYCOMBE											
HUMOSA											5.26
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY									7.02		
LANGERKOPF											
MAM-HEATH											
MILDENHALL									1.75		
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE							3.51				
MUEHLZCH											
PRUEM											
RAMSTEIN	1.75								12.28		7.02
RHEIN MAIN									3.51	1.75	
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO									14.04	3.51	
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY											
NAVY											
OTHER-EUR											7.02
CONUS											1.75

Figure C-1. USAF Base-to-Force Element Category-by Base (Rome)
(Percent of Originating AUTOVON Traffic)

SCHOENFELD	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY									1.14		
ANKARA											
ATHENS											
AVIANO							1.14				
BENTWATERS											
BERLIN											
BITBURG				1.71	2.29		5.14		1.14	1.14	13.72
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG							.57				
FYLINGDALES											
HAHN						1.14	5.71		5.14	.57	
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR									2.29		
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY									4.0		
LANGERKOPF											4.0
MAM-HEATH											
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN							.57		1.71	1.14	2.29
RHEIN MAIN							14.86			.57	
ROME											
SCHOENFELD							.57				
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON							2.86				
U. HEYFORD											
WEATHERSFIELD							2.29				
WIESBADEN							3.43			.57	1.14
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										5.71	4.58
NAVY											
OTHER-EUR											2.86
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (Schoenfeld)
(Percent of Originating AUTOVON Traffic)

SCOTT	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO											
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											6.67
FYLINGDALES											
HAHN				3.33					5.0		1.67
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK									1.67		
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											
MAM-HEATH											
MILDENHALL		1.67							5.0	3.33	1.67
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	1.67								10.0		1.67
RHEIN MAIN		5.0			5.0		1.67		21.67		3.33
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY											20
NAVY											
OTHER-EUR											6.67
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (Scott)
(Percent of Originating AUTOVON Traffic)

SCULTHORPE	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY									1.33		
ANKARA											
ATHENS											
AVIANO											
BENTWATERS											1.33
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH	1.33		5.33	13.33	6.67	12	2.67		6.67	2.67	18.67
LINDSEY											
LANGERKOPF											
MAM-HEATH											
MILDENHALL	2.67								4.0	1.33	1.33
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	1.33				1.33				1.33		1.33
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE									1.33		
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD									4.00		1.33
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY											
NAVY											
OTHER-EUR											5.33
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (Schulthorpe) (Percent of Originating AUTOVON Traffic)

SEMBACH	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY		.11		.11					.34	.11	
ANKARA									.11		
ATHENS				.11							.11
AVIANO									.23		
BENTWATERS		.11	.34	.11					.45	.11	.23
BERLIN					.11					.23	.23
BITBURG	.23				.11				1.02		.90
BOTLEY HILL											
CHICKSANDS									.11		
CROUGHTON									.11		.45
DIYARBIKIR											
FELDBERG							.11				.23
FYLINGDALES											
HAHN	.11	.68	.23			.11			.34	.11	.34
HILLINGDON											.23
H. WYCOMBE									.11		.11
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH		.23							.23		.23
LINDSEY									3.01		
LANGERKOPF							1.72				5.63
MAM-HEATH											.11
MILDENHALL		.11			.11				.23		.45
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											.90
MUEHLZCH							.11				
PRUEM											
RAMSTEIN	2.38	.34	.23	.45	.23	.23	.34	.34	1.70	.79	1.91
RHEIN MAIN		.23		.90	1.13	.11		.11	.68	.11	1.25
ROME											
SCHOENFELD							.11				.68
SCULTHORPE											
SEMBACH									.11		
SOESTERBERG										.34	
SPANGDAHLEM	.11	.11	.23	.23	.34	.23			.11	.23	.90
SAN VITO											
TEMPELHOF									.57		
THULE											
TORREJON				.11	.11				.57	.23	.45
U. HEYFORD		.57		.23			.11		.23		
WEATHERSFIELD											
WIESBADEN	.57			.34	.23	.23	.34			.57	1.45
WOODBRIDGE											
ZARAGOZA		.79	3.17	.34	.11		.23		1.36	.68	.79
ZWEIBRUCKEN	.11	.23		.11	.34		.11		.34		.68
ARMY										31.45	13.68
NAVY										1.27	.23
OTHER-EUR										1.47	.79
CONUS											2.26

Figure C-1. USAF Base-to-Force Element Cateogry-by Base (Semach)
(Percent of Originating AUTOVON Traffic)

SOSTRBRG	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO											
BENTWATERS											
BERLIN											
BITBURG						1.41					
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											1.41
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN				5.63			1.41			8.45	2.82
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											
MAM-HEATH											
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	11.27						11.27		11.27		7.04
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											1.41
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN						1.41					1.41
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN		5.63							2.82		
ARMY										18.31	7.04
NAVY											
OTHER-EUR											
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (Soesterberg)
(Percent of Originating AUTOVON Traffic)

SPANGDAHLEM	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY				.15	.08				.38		
ANKARA											
ATHENS											
AVIANO										.23	
BENTWATERS			.08		1.07				.54		.08
BERLIN											
BITBURG		.61	.08	1.0	.77	.61	.08		1.23	1.07	3.38
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN		.08	.92	.92	.46	.31	.08		3.38	1.30	1.69
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											.15
IRAKLION											
IZMIR											
KARAMURSEL											.15
KAPAUN BKS											
LAKENHEATH		.31		.08	.15	.23	.15				.23
LINDSEY											
LANGERKOPF											
MAM-HEATH											
MILDENHALL			.23	.23	.08						.08
MORON											.15
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH							.08				
PRUEM											
RAMSTEIN	2.61			.31	.46	.46	.08		4.91	.08	3.99
RHEIN MAIN		.77	.77	.84	.15		.08	.08	1.30	.61	2.15
ROME				.15						.23	
SCHOENFELD							.23				1.61
SCULTHORPE											
SEMBACH	.08	.15		.31	.08				.69		.38
SOESTERBERG											
SPANGDAHLEM	1.30										
SAN VITO											.08
TEMPELHOF											
THULE											
TORREJON			.08				.46		.38		.15
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN	.31					.23	.15		2.84	.54	1.69
WOODBRIDGE											
ZARAGOZA		1.15	2.30		.61	.38	.08		1.46		.84
ZWEIBRUCKEN		.69	.38	.38	.38				.77	.69	1.07
ARMY										26.48	.15
NAVY										2.92	
OTHER-EUR										1.30	.16
CONUS											1.84

Figure C-1. USAF Base-to-Force Element Category-by Base (Spangdahlem) (Percent of Originating AUTOVON Traffic)

SAN VITO	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY									.32		
ANKARA											
ATHENS				.32	.32				1.92		
AVIANO					.32		.32		6.71		1.28
BENTWATERS											
BERLIN										.32	
BITBURG			1.28								.64
BOTLEY HILL											
CHICKSANDS									.96		
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN									.32	.32	.32
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION									3.51		
IZMIR											
KARAMURSEL									.96		
KAPAUN BKS											
LAKENHEATH						.64					
LINDSEY									7.99		
LANGERKOPF											2.24
MAM-HEATH											.32
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI							.64				
MT. PATERAS											.64
MT. REGGIO							1.28				
MT. VERGINE							.96				.64
MUEHLZCH											
PRUEM											
RAMSTEIN	.96								2.56		.96
RHEIN MAIN		1.60			.32				.32		
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH									.32		
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF									1.60		
THULE											
TORREJON									.64		
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN						5.75					2.88
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										9.59	9.58
NAVY										10.54	3.52
OTHER-EUR											.32
CONUS											11.82

Figure C-1. USAF Base-to-Force Element Category-by Base (San Vito)
(Percent of Originating AUTOVON Traffic)

TEMPELHOF	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS											
AVIANO											
BENTWATERS											
BERLIN											
BITBURG									3.31		
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN									.66		
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											
MAM-HEATH											
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	3.97	12.58					3.31		1.32	11.92	3.97
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH	.66			13.91					2.65		7.28
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN							2.65				
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										11.92	5.96
NAVY											3.97
OTHER-EUR											
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (Tempelhof) (Percent of Originating AUTOVON Traffic)

THULE	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA									33.33		
ATHENS											
AVIANO											
BENTWATERS											
BERLIN											
BITBURG											
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH											
LINDSEY											
LANGERKOPF											
MAM-HEATH											
MILDENHALL											
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN											
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY											
NAVY											
OTHER-EUR											
CONUS											66.67

Figure C-1. USAF Base-to-Force Element Category-by Base (Thule)
(Percent of Originating AUTOVON Traffic)

TORREJON	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY											
ANKARA											
ATHENS				.22	1.54				1.98		.44
AVIANO		.22							5.29		.88
BENTWATERS			.44		.22						
BERLIN											
BITBURG									.44		.22
BOTLEY HILL											
CHICKSANDS									.22		
CROUGHTON									.22		.66
DIYARBIKIR									.44		
FELDBERG											
FYLINGDALES											
HAHN									.44		.22
HILLINGDON											
H. WYCOMBE									.22		
HUMOSA							.22				
INCIPLIK									5.29		3.3
IRAKLION									.88		
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH		.22			.22	.66			.66		
LINDSEY									2.64		.88
LANGERKOPF							.44				
MAM-HEATH											
MILDENHALL				.44	.22				1.32		
MORON					.22		.22				.22
MT. FRANCA											
MT. LIMBARI							.66				
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	5.72		.22		1.10		.66		13.0	.22	2.64
RHEIN MAIN	.22	.88			.22				.44		1.54
ROME										.44	
SCHOENFELD											
SCULTHORPE											
SEMBACH					.22				.66		.44
SOESTERBERG											
SPANGDAHLEM			.22						.22	.22	.88
SAN VITO									.22		
TEMPELHOF											
THULE											
TORREJON									.44		
U. HEYFORD	.44				.88				.22		.22
WEATHERSFIELD											
WIESBADEN	.66					.22	.22			.44	
WOODBRIDGE											
ZARAGOZA			.44		2.42		.44	.22	2.42		.88
ZWEIBRUCKEN									.44	.44	
ARMY											1.98
NAVY											
OTHER-EUR											.88
CONUS											16.88

Figure C-1. USAF Base-to-Force Element Category-by Base (Torrejon)
(Percent of Originating AUTOVON Traffic)

U. HEYFORD	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY		.11	.11	.56	.22	.11		.11	3.23	.11	.33
ANKARA											
ATHENS						.11			.22		
AVIANO				.22					.44		
BENTWATERS		.22	.11	1.45	.44		.56		2.89		1.33
BERLIN											
BITBURG			.11								.22
BOTLEY HILL											
CHICKSANDS									1.78		
CROUGHTON									.11		
DIYARBIKIR									.11		
FELDBERG											
FYLINGDALES											
HAHN									.11	.22	
HILLINGDON							.22				
H. WYCOMBE	.11				.78	.22			4.12	1.89	2.67
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH	.11	.33	.67	1.45	.56	2.11			3.45	.33	2.67
LINDSEY											
LANGERKOPF											
MAM-HEATH							.11				
MILDENHALL	2.11	.11	.11	1.00	1.89			.11	1.56	1.78	2.67
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	13.46	.22		.56	1.56	.11			6.34	.11	9.79
RHEIN MAIN	.11	.22					.22	.11	.44	.67	1.33
ROME											
SCHOENFELD											
SCULTHORPE		.11		.11							
SEMBACH		.11		.44			.22		.33	.44	1.56
SOESTERBERG										.11	
SPANGDAHLEM				.11					.22		
SAN VITO									.67		
TEMPELHOF											
THULE											
TORREJON			.11	.33					.33		
U. HEYFORD		.11					.11		1.33	.11	
WEATHERSFIELD											
WIESBADEN	2.22	.11			.11	.44	.11	.11		.11	
WOODBRIDGE											
ZARAGOZA		.11							.11	.11	
ZWEIBRUCKEN				.22					.33		.11
ARMY											
NAVY											
OTHER-EUR											
CONUS											.11

Figure C-1. USAF Base-to-Force Element Category-by Base (U. Heyford)
(Percent of Originating AUTOVON Traffic)

WEATHERSFIELD	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY									22.81		.51
ANKARA											
ATHENS											
AVIANO											
BENTWATERS									2.74		.69
BERLIN										.51	.17
BITBURG											
BOTLEY HILL											
CHICKSANDS									2.40		
CROUGHTON									2.74		.17
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											.17
HILLINGDON							.17				.17
H. WYCOMBE									1.54		
HUMOSA											
INCIRLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH									3.60	.51	.69
LINDSEY											
LANGERKOPF											.34
MAN-HEATH							.51				
MILDENHALL									3.43	.17	.17
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	.17				.17				1.89		.51
RHEIN MAIN											
ROME											
SCHOENFELD											
SCULTHORPE									.51		
SEMBACH									.69		
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF									.34		
THULE											
TORREJON											.17
U. HEYFORD									1.37		.17
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY										2.92	2.06
NAVY										.17	3.26
OTHER-EUR										.17	5.32
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (Weathersfield)
(Percent of Originating AUTOVON Traffic)

WOODBRIDGE	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY			.79								
ANKARA											
ATHENS											
AVIANO											
BENTWATERS											
BERLIN											
BITBURG									.79		
BOTLEY HILL											
CHICKSANDS											
CROUGHTON							.79				
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN											
HILLINGDON											
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH									.79		
LINDSEY											
LANGERKOPF											
MAM-HEATH											
MILDENHALL				2.38					3.97	2.38	2.38
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	.79								.79	.79	
RHEIN MAIN				.79					.79		
ROME											
SCHOENFELD											
SCULTHORPE											
SEMBACH											
SOESTERBERG											
SPANGDAHLEM											
SAN VITO											
TEMPELHOF											
THULE											
TORREJON											
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN											
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN											
ARMY											
NAVY											
OTHER-EUR											
CONUS											80.12

Figure C-1. USAF Base-to-Force Element Category-by Base (Woodbridge)
(Percent of Originating AUTOVON Traffic)

ZARAGOZA	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY			.20	. 41					7.99		.82
ANKARA											
ATHENS									.20	.20	
AVIANO									.82	.20	.20
BENTWATERS									.41	.61	.20
BERLIN											
BITBURG					.41		.41		.61		.20
BOTLEY HILL											
CHICKSANDS											
CROUGHTON											
DIYARBIKIR											
FELDBERG											
FYLINGDALES											
HAHN	.41	1.43	5.12	.61	1.02	.82			2.25		3.48
HILLINGDON											
H. WYCOMBE										.20	
HUMOSA											
INCIPLIK									1.64		
IRAKLION									1.84		
IZMIR											
KARAMURSEL											
KAPAUN BKS											
LAKENHEATH						.20			.20		
LINDSEY									3.07		1.02
LANGERKOPF											
MAN-HEATH											
MILDENHALL	.20		.20	.41				.20	2.25	.41	.61
MORON				.20			.20			.61	.20
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	4.92	.20	1.64		.61				7.58	.20	4.10
RHEIN MAIN				.51					1.23	.20	.41
ROME											
SCHOENFELD											
SCULTHORPE									.20		.41
SEMBACH	.20			.41		.20			.41		1.64
SOESTERBERG										2.05	
SPANGDAHLEM		.41	2.25		.61	.20			1.02		4.10
SAN VITO											
TEMPELHOF											
THULE											
TORREJON	.20	.41	2.05	2.46	1.43	.20	.41		1.23	.82	3.48
U. HEYFORD											
WEATHERSFIELD											
WIESBADEN	.41					1.84	1.02			.20	
WOODBRIDGE											
ZARAGOZA											
ZWEIBRUCKEN				.20	.20				1.23		.20
ARMY											
NAVY											
OTHER-EUR											
CONUS											.61

Figure C-1. USAF Base-to-Force Element Category-by Base (Zaragoza)
(Percent of Originating AUTOVON Traffic)

ZWEIBRUCKEN AFB	01 COMMAND	02 OPERATIONS	03 MAINT.	04 RESOURCES MGMT.	05 COMBAT SUP.GRP.	06 MEDICAL	07 COMM.	08 WEATHER	09 OPERATORS	10 TENANTS	99 NOT IN DIRECTORY
ALCONBURY		.17		1.04					1.91		.17
ANKARA											
ATHENS									.17		
AVIANO											
BENTWATERS		.35	.17	.87	.35				.87		.17
BERLIN										.35	
BITBURG	.17		.17	1.56	.17				.52		.52
BOTLEY HILL											
CHICKSANDS									1.21		
CROUGHTON									.17		.52
DIYARBIKIR											
FELDBERG											.17
FYLINGDALES											
HAHN			.35	.52	.17				1.04		1.56
HILLINGDON											.17
H. WYCOMBE											
HUMOSA											
INCIPLIK											
IRAKLION											
IZMIR											
KARAMURSEL									.17		
KAPAUN BKS											
LAKENHEATH			.17		.17	.17	.52		.35		.52
LINDSEY									.87		
LANGERKOPF											.87
MAM-HEATH											
MILDENHALL	.69								.17		.35
MORON											
MT. FRANCA											
MT. LIMBARI											
MT. PATERAS											
MT. REGGIO											
MT. VERGINE											
MUEHLZCH											
PRUEM											
RAMSTEIN	4.38	.52	1.91	1.04	2.25	.87	.87		3.12	.52	6.23
RHEIN MAIN		.69		1.39	.17	.17	.17		1.39	.52	1.91
ROME										.17	
SCHOENFELD											
SCULTHORPE											
SEMBACH	.52			.35	.17				.35	.17	.87
SOESTERBERG											
SPANGDAHLEM		.52	.17	.17	.35			.17	1.56		.87
SAN VITO											
TEMPELHOF									1.04		
THULE											
TORREJON	.52	.17	.17	.52	.17				.69	.35	.52
U. HEYFORD									.52		
WEATHERSFIELD											
WIESBADEN	.17					.52		.17		.52	.87
WOODBRIDGE											
ZARAGOZA		.17	.35	.35					.52	.17	.35
ZWEIBRUCKEN							.17		.17	.69	
ARMY										28.59	4.35
NAVY										.17	.35
OTHER-EUR											.35
CONUS											

Figure C-1. USAF Base-to-Force Element Category-by Base (Zweibrucken AFB)
(Percent of Originating AUTOVON Traffic)

Appendix D
The Computation of Offered Traffic

1.0 Saturated Networks

When the traffic in a network approaches its capacity, the network is said to be in a saturated condition. Under these circumstances, the traffic that is "carried" by the network is no longer dependent principally on user demands. On the contrary, in a truly saturated condition the carried traffic is essentially network determined. Once the capacity of a network is reached, increased user demands have an insignificant effect on the amount of traffic that can be passed through or carried.

These observations are usually unimportant in the United States commercial telephone industry, because networks are designed so that capacity limits are not approached in such a way as to be a factor in determining carried traffic. In the commercial networks the traffic that is carried is essentially the traffic that the user wishes to pass, *i.e.*, the offered traffic.

As a practical matter, it is the usual commercial practice to measure the traffic carried by the network and then treat this as the corresponding offered traffic in the network engineering process. In short, for the U.S. commercial telephone networks, there exists a practical equivalence between offered and carried traffic. Unfortunately, this equivalence cannot be extended in the case of the AUTOVON network. The reason for this is that much of AUTOVON is in a highly saturated condition. Therefore, in the analysis of AUTOVON traffic patterns, it is necessary to make a precise distinction between the notion of carried and offered traffic. In what follows "carried" traffic should be taken to mean the traffic that actually exists in the network. On the other hand, "offered" traffic is that which would exist in the network given no network capacity limitations. With these definitions, it follows that a saturated network implies offered traffic in excess of that carried and in an unsaturated network offered and carried traffic are approximately equal.

Since offered traffic depends on human behavior, it is difficult to measure. What we measure instead is the carried traffic which actually exists in the network. TDCS, for example, measures traffic carried on AUTOVON. The problem then is how to convert these measurements into estimates of the offered traffic which are in fact user needs.

2.0 Repeated Attempts

In a saturated network the difference between offered and carried traffic is lost. That is, this difference is not passed by the network and the calls which comprise this lost traffic are unsuccessful (do not result in conversation). Interestingly, congestion or blockage of the network is not the primary reason for unsuccessful calls according to commercial experience in the United States. The most common reasons for failure are:

- Incomplete dialing
- Incorrect dialing
- Technical faults
- Hang up before answer
- Busy called party
- No answer

In AUTOVON, however, network congestion at the access lines will be seen to be a major factor leading to unsuccessful routine traffic.

Because of the relative unimportance of congestion in the commercial network, telephone traffic theory has historically assumed that calls rejected due to congestion do not change the intensity of originating traffic. Commonly it is assumed that blocked calls wait only their intended holding time and then abandon (Poisson) or alternatively do not wait at all but are cleared (Erlang B) [1]. This simplifies the theory and provides a good approximation as long as congestion is a minor factor.

In analyzing AUTOVON's traffic it would not be realistic to ignore the impact of blocked calls on the users of the network. Every failure is a potential new attempt. In fact, unsuccessful callers are likely to try again whether the failure is due to congestion or other reasons. An examination of AUTOVON call data reveals many sequences of reattempts as the same number is dialed repeatedly. If each attempt is considered an initial attempt, as is done in the classical theory, a serious overstatement of the offered traffic would be made. In the development to follow it will be necessary to take explicit account of the effect of reattempts and the fact that users change their intensity of origination in response to a change in the probability of a successful attempt.

3.0 Engineering Basis

The term traffic is used here principally to mean usage expressed in Erlang's or CCS. Usage is computed by multiplying the number of calls during a specified period by their average holding time. Thus usage is a function of the period over which it is measured.

Since traffic engineering measurements are generally used to determine how much telephone equipment is necessary, the period selected for study is usually a busy one with the idea that equipment adequate for this period will be more than adequate for other times during the day. The usual commercial practice in selecting a busy period is to choose the "busy hour" in the "busy season". The definitions of busy hour and busy season are quite arbitrary. Some examples of commonly used terms are:

- Time consistent busy hour
- Group busy hour
- Office busy hour
- Ten high weeks
- Bouncing busy hour

Without defining these terms, it should be apparent that there is no universal agreement on what constitutes the busy period.

Once a busy period has been selected, the equipment necessary to provide a certain grade of service during that period is computed. Hence, the specific period and the associated traffic measured in that period serve as the engineering basis. It is interesting to note that from a practical point of view the selection of a busy period is every bit as important in determining the provision of equipment as the specific service criteria employed.

Engineering the AUTOVON network is, of couse, beyond the scope of this study. However, it is necessary to define the period during which usage is measured or computed. Toward this end we have chosen the busiest hour of the day as the basis for usage computations — that is, the hour with the most usage for the equipment group in question. Since data is only available for certain days it was not possible to make a determination of the busy season. Call data indicates that hourly and daily variation of usage during the normal hours of operation is not great. In fact, the comparatively flat usage pattern observed on AUTOVON is to be expected due to congestion and low probability of completion for routine traffic as we shall see later. In what follows, usage, then, should be taken to mean usage during the busiest hour for the group and day stated.

4.0 Historical Approaches

The problem of computing offered traffic in an environment of repeated attempts is as old as telephony itself. However, interest in the subject has been persistent and in the last International Teletraffic Congress (8th) several relevant papers appeared. Despite the availability of the literature, commercial practice in this and other countries rarely, if ever, explicitly considers the effect of reattempts. As we have pointed out earlier, this is due in a large part to the fact that commercial service generally minimizes the effect of congestion and the associated reattempts. However, there are other reasons for the lack of popularity of existing approaches. First, most of the models dealing with reattempts are mathematically complex relative to current engineering practice, and second even where the theory is relatively simple it requires measurements that are difficult, costly, or uncommon.

Perhaps the most comprehensive and elegant characterization of the reattempt phenomenon has been achieved through the use of the state equations model as exemplified by Elldin [2]. Basically this approach is an application of the theory of Markov Processes. Call sources are considered to be in certain states depending on the disposition of their calls, and then transition probabilities are developed among states. With this information the equations for steady state probabilities are developed for the various states of the network. Solution of these equations is accomplished on a computer using the method of successive overrelaxation. The advantage of this approach is that it gives a complete statistical characterization of

the process. The disadvantage has to do with the many parameters that must be estimated and the calculation time which is proportional to the number of possible states in the system.

Most of the other well known models including the one to be used in this study employ the basic idea that the carried traffic E_o is equal to the offered traffic E_c multiplied by the probability P_c that the user will complete his call successfully in a sequence of attempts.

$$E_c = E_o P_c \tag{1}$$

In this form Equation (1) ignores the usage of an unsuccessful attempt but it can be modified to include this effect. With this general relation between carried and offered traffic, the literature differs on how one might proceed in computing P_c.

Le Gall [3] has postulated that a useful form for this probability of success is given by

$$P_c = r\beta \tag{2}$$

where r is the "efficiency rate", *i.e.*, the ratio of successful to unsucessful calls and β is the mean number of attempts per initial attempt. Reportedly, this relation has worked quite well in Paris. The model could be criticized in that it does not explicitly take into account the effect of different causes of failure. That is, it uses an average number of attempts, but since the parameter β is computed empirically this may not be too important. There is, however, the disadvantage that in order to estimate β it is necessary to observe a sample of callers which requires a service-observing type of study.

Another empirical approach which has been advocated uses the basic equations of Le Gall but assumes a specific form for the relationship between r and β

$$\beta = r^{-\alpha}, 0 \leq \alpha \leq 1 \tag{3}$$

In this way, once α has been determined by a special study, β can be estimated by only measuring r. Guerineau, *et al* [4] report on this approach. Gosztony [5] using a simulation indicates that the exponent α is constant if there is no change in the user's perseverance in making calls. It is interesting that Equation (3) implies that as a user's chance of success is reduced (decreased r) the number of attempts he will make increases. La Gall observed this phenomenon in [3] by pointing out that in Paris as the efficiency rate drops from 70% to 40% the successful traffic decreases only 10% due to the perseverance of the users.

The remaining models common in the literature are called by Gosztony the Erlang group. Equation (1) is still central; however, use is made of the classic Erlang

formulas in computing a fictitious offered traffic which is the product of the total number of attempts and the average holding time (measured). The idea is that, using the Erlang formulas it should be possible to compute the traffic presented to the network since calls arrive randomly in spite of repetitions. Then this fictitious offered traffic can be adjusted to take out the effect of reattempts. This general approach is the one we have chosen for the study of AUTOVON for two reasons. First, this method requires the kind of data which is consistent with that provided by TDCS, and second it relies on the Erlang models with which practical experience has been excellent. Honi [6] presents a development which is similar to the one we shall employ.

5.0 Basic Approach

The general method to be used for computing offered traffic in AUTOVON requires first for each base a determination of the probability P_s that a single originating attempt is successful. With this information and the model of user behavior to be presented in the next section, one can calculate the probability P_C that a user is successful in a sequence of attempts before he gives up trying. The number of offered initial attempts N_o is then given by

$$N_o = \frac{E_c}{P_c h_c} \tag{4}$$

where E_c is the successful originating usage in the busy hour and h_c is the average holding time for that usage. Based on dialing and connection time, an AUTOVON call that lasts more than 25 seconds is considered to be successful.* This assumption together with the TDCS data allows the computation of E_c and h_c.

For each offered initial attempt there is also an expected number of attempts which reach announcement trunks or a subscriber unavailability condition. These attempts generate usage also. In the next section we compute n_A, the expected number of attempts which reach an announcement trunk per initial attempt and n_B, the expected number of attempts that reach a busy or no answer per initial attempt. If the view is taken that calls which reach announcement trunks or a subscriber unavailable condition do so for reasons unrelated to the network, *i.e.*, user reasons, then this usage must be considered in computing offered traffic. In this study we will consider the offered traffic to consist of three components —conversational traffic, attempts reaching announcement trunks, and attempts resulting in no answer or busy. Mathematically then, the offered traffic E_o for each base is computed by

$$E_o = \frac{E_c}{P_c\, h_c}(h_c + n_A\, h_A + n_B\, h_B) \tag{4}$$

*An assumption of this nature was necessary to reveal the disposition of calls due to the impracticality of call tracing through the network.

where h_A and h_B are the average holding times for attempts that reach announcement trunks and no user respectively.**

The next section details the calculations of P_s, P_c, n_A, and n_B which complete the mathematical development.

6.0 Methodology

An initiated call on the AUTOVON network may fail for one of three reasons.

1. The user fails to get an access line from the PBX.
2. The user reaches an announcement trunk.
3. The called party is not available; either busy or not there.

Each of these events will be described by the probabilities P_1, P_A, and P_B respectively where

P_1 = Probability of not getting an access line
P_A = Probability of getting an announcement trunk given an access line
P_B = Probability of getting a no answer or busy condition given an access line and that an announcement trunk was not reached.

The probability P_s that a single attempt is successful is thus given by

$$P_s = (1 - P_1)\,(1 - P_A)\,(1 - P_B) \tag{5}$$

We know, however, that a user may not make a single attempt if he is unsuccessful. Reattempts are quite likely and in fact are observed frequently in the AUTOVON call data. To model the reattempt phenomenon, we shall assume that after each unsuccessful attempt a user will try again with probability $1 - q$. Thus q is the quitting probability. The reciprocal of q is then the expected number of attempts per initial attempt given *that all attempts are unsuccessful*. Typical values of q are .5, .3, and .2 leading to values for expected attempts of 2, 3.33, and 5 respectively.

With this model of user behavior, the probability that a user is successful in exactly i attempts is

$$(1 - P_s)^{i-1}\,(1 - q)^{i-1}\,P_s \tag{6}$$

That is, he is unsuccessful on the first i-1 attempts and finally successful on the i^{th} attempt. Since a user must be successful on some attempt if he is successful at all, the probability of success P_c in a sequence of attempts is given by

**These holding times have been assumed to be 15 seconds in the calculations to follow.

$$P_c = \sum_{i=1}^{\infty} (1 - P_s)^{i-1} (1 - q)^{i-1} P_s, \text{ or} \tag{7}$$

$$P_c = \frac{P_s}{P_s + q(1 - P_s)}$$

Thus the probability of success in a sequence (per initial attempt) is a function of P_1, P_A, P_B, and q. The probability of not getting an access line from the PBX, P_1, can be computed knowing the total usage on the access lines and the number of trunks. This computation is made using the Erlang B formula for the probability of blocking [1]. The probabilities P_A and P_B are estimated by using ratios of call counts available from TDCS. For example, P_A is equal to the number of calls that reach announcement trunks divided by the total number of calls in the same period. The probability of quitting q is a function of user behavior and has not been measured for AUTOVON. Nevertheless, its value can be estimated by examining time series of call data, and then it can be treated parametrically as we shall do in the next section.

Next we compute the expected number of attempts before abandonment $\bar{n}$. Suppose i trials are made and the user makes no more attempts to reach the called party. It follows that the first $i-1$ trials were unsuccessful and that the last trial was either successful or if unsuccessful the user quits. Thus the probability of exactly 1 trials is

$$(1 - P_s)^{i-1} (1 - q)^{i-1} (P_s + (1 - P_s)q) \tag{8}$$

The expected number of trials is computed by taking the expectation with respect to i.

$$\bar{n} = \sum_{i=1}^{\infty} i(1 - P_s)^{i-1} (1 - q)^{i-1} (P_s + (1 - P_s)q) \tag{9}$$

By summing, we have

$$\bar{n} = \frac{1}{P_s + q(1 - P_s)} \tag{10}$$

We now need the expected number of announcement trunks reached, n_A, per initial trial. Suppose for the moment that only n trials are made in a sequence of

attempts. Clearly the first $n-1$ attempts are unsuccessful and these result in either an announcement trunk or subscriber unavailability condition. The first $n-1$ trials contribute

$$(n-1)\, P[A|\text{ unsuccessful}] \tag{11}$$

in an expected value sense to the value of n_A where $P[A|$ unsuccessful$]$ is the probability of an announcement trunk given that the attempt is unsuccessful. Now

$$P[A|\text{ unsuccessful}] = \frac{P[A,\text{ unsuccessful}]}{P[\text{unsuccessful}]} \tag{12}$$

Substituting,

$$P[A|\text{ unsuccessful}] = \frac{(1-P_1)\, P_A}{1-P_s} \tag{13}$$

Thus the first $n-1$ trials contribute

$$\frac{(n-1)\,(1-P_1)\, P_A}{1-P_s} \tag{14}$$

The last trial is unsuccessful or if not the user quits. It contributes

$$1 \cdot P[A|\text{ last trial}] \tag{15}$$

to n_A where $P[A|$ last trial$]$ is the probability that an announcement trunk is reached given that the trial is the last in a sequence.

$$P\, A|\text{ last trial} = \frac{P[A,\text{ last trial}]}{P\,[\text{last trial}]} \tag{16}$$

$$= \frac{(1-P_1)\, P_A\, q}{P_s + (1-P_s)\, q} \tag{17}$$

Adding Expression (14) and (15) and substituting Equation (17), we have

$$\frac{(n-1)\,(1-P_1)\, P_A}{1-P_s} + \frac{(1-P_1)\, P_A\, q}{P_s + (1-P_s)\, q} \tag{18}$$

This expression is the expected number of announcements per initial attempt given that exactly n trials were made. By taking the expectation with respect to n we then have n_A

$$n_A = \frac{(\bar{n} - 1)(1 - P_1) P_A}{1 - P_s} + \frac{(1 - P_1) P_A q}{P_s + (1 - P_s) q} \tag{19}$$

A similar calculation to determine the expected number of no answer or busies per initial attempt yield

$$n_B = \frac{(\bar{n} - 1)(1 - P_1)(1 - P_A) P_B}{1 - P_s} + \frac{(1 - P_1)(1 - P_A) P_B q}{P_s + (1 - P_s) q} \tag{20}$$

To compute n_c the expected number of successful attempts per initial attempt we need only observe that at most one attempt can be successful in a sequence of attempts. Since the probability that a successful attempt occurs is given by P_c, we have

$$n_c = P_c \tag{21}$$

We are now in a position to compute the offered traffic using Equation (4) of the previous section which is repeated here:

$$E_o = \frac{E_c}{P_c h_c}(n_c h_c + n_A h_A + n_B h_B) \tag{4}$$

It has been possible to express E_o, P_c, n_A, n_B, and n_C in terms of the fundamental parameters P_1, P_A, P_B, and q. In using Equation (4) P_c should be evaluated using the values of P_1, P_A, P_B which are determined from the TDCS. When this is done $E_c/P_c h_c$ equals the offered initial attempts. The values of n_A and n_B should be computed using $P_1 = 0$ to eliminate the network constraint and P_A and P_B set to the quantities measured with TDCS. In this way the only impediments to traffic flow are the blocking parameters P_A and P_B.

How the offered traffic E_o is to be interpreted will depend on the way in which n_c is computed. We consider two views here. First n_c is taken to be unity. In this case called the "user needs view" the offered traffic that is computed is that which the user would put through the network given no constraints (network and non network) plus the associated unsuccessful usage assuming P_A and P_B =/ 0. The usage calculated in this way could not actually occur as long as the constraints P_A and P_B existed since some callers would give up trying when they were unsuccessful. Nevertheless this usage is what the users would like to generate if they were always successful and it thus represents an upper bound on what could be expected.

The second interpretation of offered traffic to be presented is called the "network constraint view" and is computed by setting n_c to the value given by $P_1 = 0$ and P_A and P_B equal to the values computed using the TDCS. The usage E_o calculated in this way is that which would exist on the network if only the constraint of limited access lines were removed ($P_1 = 0$). Since there are other constraints to traffic flow implicit in P_A and P_B which could be removed, this computation represents a lower bound on anticipated usage.

7.0 Computations for AUTOVON

Figure D-1 summarizes the data derived from TDCS. The particular day used was arbitrary but not atypical. The trunks studied are those which provide access from the PBX to the AUTOVON switch. Naturally usage or calls that do not reach these trunks are not observed. The total occupancy for each trunk group is obtained by adding originating and terminating occupancy. Relative to commercial experience the total occupancy of these trunk groups is extremely high thus providing a significant obstacle to call completion.

Figures D-2, D-3 and D-4 present the results of our computations using the approach described in the previous section. Each of the three Figures correspond to a particular value of q which characterizes the users lack of persistance or quitting probability. Values of q equaling 1, .5 and 0 are shown.

For the bases listed the average probability of being blocked in an attempt to obtain an access line is 17%. This result comes from the Erlang B formula. Given that an access line is obtained, the probability of being unsuccessful is 46% on the average. Le Gall [3] observed that in Paris the corresponding probability was 31%. In making the comparison with Paris one might conclude that of the 46% unsuccessful calls 31% fail due to user reasons and the remaining 15% fail for network reasons. However, such a conclusion is questionable due to the variability of human behavior leading to the 46% figure. An examination of trunk group size in the network indicates that interswitch trunking is in fact adequate. Thus it appears likely that most of the unsuccessful calls that obtain an access line fail for reasons independent of the network.

A single attempt has on the average a 47% chance of success. However, due to the persistence of the user in making repeated attempts the average probability of success in a sequence of attempts ranges from .49 to .74 depending on the value of q.

The highest values for offered traffic are computed when q equals one. For this case a user is assumed to quit after the first attempt. Thus all attempts that are observed are considered to be initial demands for service with no reattempts. The results obtained in this way correspond to the classical theory and tend to overstate the actual offered traffic.

SWITCH -BASE	BUSY HOUR	NUMBER OF TRUNKS	% ORIG OCCUPANCY	% TERM OCCUPANCY	NUMBER OF ORIG CALLS	NUMBER OF TERM CALLS	NUMBER OF ORIG CALLS 25 SEC	NUMBER OF TERM CALLS 25 SEC	SERVICE
SCH-SPG	900	10	61.00	20.00	165	71	64	28	AF
SCH-BIT	1500	10	15.00	47.00	186	39	110	10	AF
HUM-TOR	1600	12	60.50	34.30	49	198	9	104	AF
HUM-ROT	1300	11	31.00	36.70	57	46	27	24	N
HUM-ZAR	800	8	36.30	44.80	105	61	47	26	AF
HUM-MOR	1600	4	20.20	43.20	65	8	46	1	AF
HUM-KEN	1000	1	31.00	16.00	3	8	1	3	N
HUM-SID	1100	3	37.60	13.60	2	20	0	2	N
DON-HDL	1300	29	13.00	43.00	102	243	36	73	AR
DON-MUN	1300	10	31.00	33.00	48	68	18	10	AR
DON-WOR	1500	6	38.00	48.00	24	91	8	38	AR
DON-KLN	1400	20	16.00	72.00	103	347	48	98	AR
DON-MAN	1300	10	28.00	52.00	59	127	20	31	AR
DON-BDK	1500	4	59.00	15.00	49	8	19	1	AR
LKF-AUG	1400	8	14.00	11.00	37	31	21	14	AR
LKF-SEM	1500	11	36.00	23.00	110	83	45	35	AF
LKF-STU	1500	9	21.00	24.00	61	56	28	17	AR
D&L-VAI	1315	41	35.50	17.10	393	130	181	36	JOINT
D&L-MAS	1500	2	24.50	4.00	31	3	22	2	AR
D&L-RAM	1415	40	31.00	45.00	406	471	191	139	AF
S&F-HAN	810	8	57.75	6.25	167	9	87	0	AF
FEL-BRE	700	12	24.00	32.00	73	39	24	9	AR
FEL-BER	1300	8	37.00	26.00	79	51	31	14	JOINT
FEL-NUR	1312	9	27.00	36.00	63	56	25	16	AR
FEL-GIE	1200	4	28.00	44.00	39	21	20	8	AR
FEL-WUR	1400	4	29.00	47.00	20	38	4	11	AR
FEL-RHE	1300	19	20.00	40.00	185	241	96	90	AR
FEL-LIN	1300	28	30.00	38.00	381	252	243	79	JOINT
FEL-FRT	800	15	17.00	63.00	55	211	18	54	AR
CTO-AVI	1300	12	23.08	30.50	82	88	33	11	AF
CTO-LEG	1300	9	38.80	6.70	114	15	61	6	AR
CTO-VIC	900	9	59.56	17.44	108	23	36	2	AR
MTV-AGN	1200	13	20.46	8.85	51	29	13	6	N
MTV-NAP	800	8	19.25	30.25	36	80	7	21	N
MTV-SIG	900	6	71.33	16.67	20	42	7	13	N
MTV-SVI	800	4	28.50	35.25	19	38	4	7	AF
MAM-SCL	800	2	41.50	9.50	23	5	7	1	AF
MAM-UHE	800	10	30.00	38.60	111	73	53	26	AF
MAM-WEA	1300	10	34.00	17.50	58	42	18	11	AF
MAM-LAK	800	10	53.80	15.50	182	41	85	11	AF
MAM-KEF	1000	4	29.25	21.75	19	11	4	1	N
H&M-MLD	915	15	38.74	29.67	183	126	93	43	AF
MAM-ALC	1400	12	48.17	20.42	149	45	51	9	AF
MAM-BEN	800	10	47.70	26.30	148	65	74	21	AF
MAM-HAR	1300	2	26.00	32.00	6	7	0	0	AR
MAM-EDZ	800	2	39.50	13.50	20	5	11	1	N
MAM-LDY	1400	1	28.00	19.00	13	8	7	5	N
H&M-LON	789	21	29.33	15.57	169	80	83	20	N
HIN-CHI	800	6	54.50	12.50	82	11	33	2	AF
HIN-CRO	800	6	28.67	36.17	65	41	36	20	AF
HIN-BUR	1000	4	26.25	17.75	21	7	10	0	AR
HIN-HIW	700	10	39.70	25.10	76	32	26	3	AF
HIN-BAH	1500	1	43.00	53.00	5	6	1	1	N
LKF-ZWE	1500	8	25.13	22.50	68	42	36	11	AF
LKF-ZWE	1400	3	28.67	20.00	37	11	19	3	AR

Figure D-1. TDCS Data Summary

Q = 1.000

SWITCH -BASE	NO ACCESS	FAILURE GIVEN ACCESS	CONVERSATION ON ATTEMPT	CONVERSATION ON SEQUENCE	TOTAL ERLANGS CARRIED	CONVERSATIONAL ERLANGS CARRIED	HOLDING TIME FOR SUCCESSFUL ATTEMPTS	ERLANGS OFFERED
	PROBABILITY OF							
SCH-SPG	0.252	0.388	0.458	0.458	6.100	5.833	0.058	13.099
SCH-BIT	0.064	0.591	0.382	0.382	1.500	1.042	0.014	3.215
HUM-TOR	0.597	0.184	0.329	0.329	7.260	7.222	0.181	22.030
HUM-ROT	0.087	0.474	0.480	0.480	3.410	3.297	0.110	6.987
HUM-ZAR	0.309	0.448	0.382	0.382	2.904	2.708	0.047	7.374
HUM-MOR	0.246	0.708	0.221	0.221	0.808	0.616	0.032	3.049
HUM-KEN	0.470	0.333	0.353	0.353	0.310	0.306	0.153	0.873
HUM-SID	0.198	0.	0.802	0.802	1.128	1.128	0.564	1.406
DON-HDL	0.001	0.353	0.646	0.646	3.770	3.620	0.055	5.752
DON-MUN	0.076	0.375	0.578	0.578	3.100	3.025	0.101	5.318
DON-WOR	0.486	0.333	0.342	0.342	2.280	2.247	0.140	6.628
DON-KLN	0.230	0.466	0.411	0.411	3.200	3.000	0.055	7.556
DON-MAN	0.236	0.339	0.505	0.505	2.800	2.717	0.070	5.490
DON-BDK	0.380	0.388	0.379	0.379	2.360	2.281	0.076	6.138
LKF-AUG	0.001	0.568	0.432	0.432	1.120	1.032	0.065	2.477
LKF-SEM	0.041	0.409	0.567	0.567	3.960	3.773	0.058	6.853
LKF-STU	0.015	0.459	0.533	0.533	1.890	1.773	0.054	3.448
D&L-VAI	0.000	0.461	0.539	0.539	14.555	13.801	0.065	26.339
D&L-MAS	0.111	0.710	0.258	0.258	0.490	0.398	0.044	1.647
D&L-RAM	0.020	0.470	0.519	0.519	12.400	11.604	0.054	23.176
S&F-HAN	0.107	0.521	0.428	0.428	4.620	4.257	0.053	10.363
FEL-BRE	0.025	0.329	0.654	0.654	2.880	2.780	0.057	4.350
FEL-BER	0.100	0.392	0.547	0.547	2.960	2.831	0.059	5.321
FEL-NUR	0.083	0.397	0.553	0.553	2.430	2.326	0.061	4.320
FEL-GIE	0.351	0.513	0.316	0.316	1.120	1.037	0.055	3.410
FEL-WUR	0.411	0.200	0.472	0.472	1.160	1.143	0.071	2.453
FEL-RHE	0.012	0.519	0.475	0.475	3.800	3.400	0.038	7.561
FEL-LIN	0.014	0.638	0.357	0.357	8.400	7.387	0.054	21.709
FEL-FRT	0.153	0.327	0.569	0.569	2.550	2.475	0.067	4.435
CTO-AVI	0.019	0.402	0.586	0.586	2.770	2.632	0.054	4.630
CTO-LEG	0.016	0.535	0.457	0.457	3.492	3.238	0.061	7.338
CTO-VIC	0.216	0.333	0.522	0.522	5.360	5.210	0.072	10.166
MTV-AGN	0.000	0.255	0.745	0.745	2.660	2.606	0.069	3.552
MTV-NAP	0.034	0.194	0.779	0.779	1.540	1.511	0.052	1.971
MTV-SIG	0.535	0.350	0.302	0.302	4.280	4.251	0.327	14.141
MTV-SV1	0.249	0.211	0.593	0.593	1.140	1.123	0.075	1.918
MAM-SCL	0.303	0.304	0.485	0.485	0.830	0.801	0.050	1.693
MAM-UHE	0.108	0.477	0.466	0.466	3.000	2.779	0.048	6.209
MAM-WEA	0.024	0.310	0.673	0.673	3.400	3.325	0.083	5.017
MAM-LAK	0.113	0.467	0.473	0.473	5.380	5.026	0.052	11.036
MAM-KEF	0.134	0.211	0.684	0.684	1.170	1.153	0.077	1.705
MAM-MLD	0.055	0.508	0.465	0.465	5.810	5.423	0.060	12.084
MAM-ALC	0.082	0.342	0.604	0.604	5.780	5.568	0.057	9.452
MAM-BEN	0.158	0.500	0.421	0.421	4.770	4.462	0.060	10.966
MAM-HAR	0.377	0.	0.623	0.623	0.520	0.520	0.087	0.835
MAM-EDZ	0.323	0.550	0.304	0.304	0.790	0.744	0.083	2.512
MAM-LDY	0.470	0.538	0.245	0.245	0.280	0.251	0.042	1.080
H&M-LON	0.000	0.491	0.509	0.509	6.159	5.814	0.068	11.776
HIN-CHI	0.188	0.402	0.485	0.485	3.270	3.133	0.064	6.627
HIN-CRO	0.167	0.554	0.372	0.372	1.720	1.570	0.054	4.405
HIN-BUR	0.085	0.476	0.479	0.479	1.050	1.008	0.092	2.150
HIN-HIW	0.081	0.342	0.605	0.605	3.970	3.862	0.077	6.503
HIN-BAH	0.960	0.200	0.032	0.032	0.430	0.426	0.106	13.411

Figure D-2. Offered Traffic for

Q = 0.500

SWITCH -BASE	PROBABILITY OF NO ACCESS	PROBABILITY OF FAILURE GIVEN ACCESS	PROBABILITY OF CONVERSATION ON ATTEMPT	PROBABILITY OF CONVERSATION ON SEQUENCE	TOTAL ERLANGS CARRIED	CONVERSATIONAL ERLANGS CARRIED	HOLDING TIME FOR SUCCESSFUL ATTEMPTS	ERLANGS OFFERED
SCH-SPG	0.252	0.388	0.458	0.628	6.100	5.833	0.058	9.610
SCH-BIT	0.064	0.591	0.382	0.553	1.500	1.042	0.014	2.364
HUM-TOR	0.597	0.184	0.329	0.495	7.260	7.222	0.181	14.648
HUM-ROT	0.087	0.474	0.480	0.649	3.410	3.297	0.110	5.200
HUM-ZAR	0.309	0.448	0.382	0.553	2.904	2.708	0.047	5.151
HUM-MOR	0.246	0.708	0.221	0.361	0.808	0.616	0.032	1.946
HUM-KEN	0.470	0.333	0.353	0.522	0.310	0.306	0.153	0.592
HUM-SID	0.198	0.	0.802	0.890	1.128	1.128	0.564	1.267
DON-HDL	0.001	0.353	0.646	0.785	3.770	3.620	0.055	4.761
DON-MUN	0.076	0.375	0.578	0.732	3.100	3.025	0.101	4.210
DON-WOR	0.486	0.333	0.342	0.510	2.280	2.247	0.140	4.457
DON-KLN	0.230	0.466	0.411	0.583	3.200	3.000	0.055	5.387
DON-MAN	0.236	0.339	0.505	0.671	2.800	2.717	0.070	4.147
DON-BDK	0.380	0.388	0.379	0.550	2.360	2.281	0.076	4.255
LKF-AUG	0.001	0.568	0.432	0.603	1.120	1.032	0.065	1.799
LKF-SEM	0.041	0.409	0.567	0.723	3.960	3.773	0.058	5.408
LKF-STU	0.015	0.459	0.533	0.695	1.890	1.773	0.054	2.669
D&L-VAI	0.000	0.461	0.539	0.701	14.555	13.801	0.065	20.447
D&L-MAS	0.111	0.710	0.258	0.410	0.490	0.398	0.044	1.072
D&L-RAM	0.020	0.470	0.519	0.683	12.400	11.604	0.054	17.791
S&F-HAN	0.107	0.521	0.428	0.599	4.620	4.257	0.053	7.499
FEL-BRE	0.025	0.329	0.654	0.791	2.880	2.780	0.057	3.615
FEL-BER	0.100	0.392	0.547	0.707	2.960	2.831	0.059	4.142
FEL-NUR	0.083	0.397	0.553	0.712	2.430	2.326	0.061	3.376
FEL-GIE	0.351	0.513	0.316	0.480	1.120	1.037	0.055	2.273
FEL-WUR	0.411	0.200	0.472	0.641	1.160	1.143	0.071	1.807
FEL-RHE	0.012	0.519	0.475	0.644	3.800	3.400	0.038	5.681
FEL-LIN	0.014	0.638	0.357	0.526	8.400	7.387	0.054	15.058
FEL-FRT	0.153	0.327	0.569	0.726	2.550	2.475	0.067	3.494
CTO-AVI	0.019	0.402	0.586	0.739	2.770	2.632	0.054	3.700
CTO-LEG	0.016	0.535	0.457	0.628	3.492	3.238	0.061	5.416
CTO-VIC	0.216	0.333	0.522	0.686	5.360	5.210	0.072	7.767
MTV-AGN	0.000	0.255	0.745	0.854	2.660	2.606	0.069	3.106
MTV-NAP	0.034	0.194	0.779	0.875	1.540	1.511	0.052	1.755
MTV-SIG	0.535	0.350	0.302	0.464	4.280	4.251	0.327	9.214
MTV-SV1	0.249	0.211	0.593	0.744	1.140	1.123	0.075	1.529
MAM-SCL	0.303	0.304	0.485	0.653	0.830	0.801	0.050	1.263
MAM-UHE	0.108	0.477	0.466	0.636	3.000	2.779	0.048	4.608
MAM-WEA	0.024	0.310	0.673	0.805	3.400	3.325	0.083	4.209
MAM-LAK	0.113	0.467	0.473	0.642	5.380	5.026	0.052	8.215
MAM-KEF	0.134	0.211	0.684	0.812	1.170	1.153	0.077	1.438
H&M-MLD	0.055	0.508	0.465	0.634	5.810	5.423	0.060	8.951
MAM-ALC	0.082	0.342	0.604	0.753	5.780	5.568	0.057	7.618
MAM-BEN	0.158	0.500	0.421	0.592	4.770	4.462	0.060	7.877
MAM-HAR	0.377	0.	0.623	0.767	0.520	0.520	0.087	0.678
MAM-EDZ	0.323	0.550	0.304	0.467	0.790	0.744	0.083	1.655
MAM-LDY	0.470	0.538	0.245	0.393	0.280	0.251	0.042	0.685
H&M-LON	0.000	0.491	0.509	0.674	6.159	5.814	0.068	8.968
HIN-CHI	0.188	0.402	0.485	0.653	3.270	3.133	0.064	4.953
HIN-CRO	0.167	0.554	0.372	0.542	1.720	1.570	0.054	3.068
HIN-BUR	0.085	0.476	0.479	0.648	1.050	1.008	0.092	1.600
HIN-HIW	0.081	0.342	0.605	0.754	3.970	3.862	0.077	5.237
HIN-BAH	0.960	0.200	0.032	0.062	0.430	0.426	0.106	6.926

Figure D-3. Offered Traffic for q

Q = 0.

SWITCH -BASE	PROBABILITY OF NO ACCESS	FAILURE GIVEN ACCESS	CONVERSATION ON ATTEMPT	CONVERSATION ON SEQUENCE	TOTAL ERLANGS CARRIED	CONVERSATIONAL ERLANGS CARRIED	HOLDING TIME FOR SUCCESSFUL ATTEMPTS	ERLANGS OFFERED
SCH-SPG	0.252	0.388	0.458	1.000	6.100	5.833	0.058	6.100
SCH-BIT	0.064	0.591	0.382	1.000	1.500	1.042	0.014	1.500
HUM-TOR	0.597	0.184	0.329	1.000	7.260	7.222	0.181	7.260
HUM-ROT	0.087	0.474	0.480	1.000	3.410	3.297	0.110	3.410
HUM-ZAR	0.309	0.448	0.382	1.000	2.904	2.708	0.047	2.904
HUM-MOR	0.246	0.708	0.221	1.000	0.808	0.616	0.032	0.808
HUM-KEN	0.470	0.333	0.353	1.000	0.310	0.306	0.153	0.310
HUM-SID	0.198	0.	0.802	1.000	1.128	1.128	0.564	1.128
DON-HDL	0.001	0.353	0.646	1.000	3.770	3.620	0.055	3.770
DON-MUN	0.076	0.375	0.578	1.000	3.100	3.025	0.101	3.100
DON-WOR	0.486	0.333	0.342	1.000	2.280	2.247	0.140	2.280
DON-KLN	0.230	0.466	0.411	1.000	3.200	3.000	0.055	3.200
DON-MAN	0.236	0.339	0.505	1.000	2.800	2.717	0.070	2.800
DON-BDK	0.380	0.388	0.379	1.000	2.360	2.281	0.076	2.360
LKF-AUG	0.001	0.568	0.432	1.000	1.120	1.032	0.065	1.120
LKF-SEM	0.041	0.409	0.567	1.000	3.960	3.773	0.058	3.960
LKF-STU	0.015	0.459	0.533	1.000	1.890	1.773	0.054	1.890
D&L-VAI	0.000	0.461	0.539	1.000	14.555	13.801	0.065	14.555
D&L-MAS	0.111	0.710	0.258	1.000	0.490	0.398	0.044	0.490
D&L-RAM	0.020	0.470	0.519	1.000	12.400	11.604	0.054	12.400
S&F-HAN	0.107	0.521	0.428	1.000	4.620	4.257	0.053	4.620
FEL-BRE	0.025	0.329	0.654	1.000	2.880	2.780	0.057	2.880
FEL-BER	0.100	0.392	0.547	1.000	2.960	2.831	0.059	2.960
FEL-NUR	0.083	0.397	0.553	1.000	2.430	2.326	0.061	2.430
FEL-GIE	0.351	0.513	0.316	1.000	1.120	1.037	0.055	1.120
FEL-WUR	0.411	0.200	0.472	1.000	1.160	1.143	0.071	1.160
FEL-RHE	0.012	0.519	0.475	1.000	3.800	3.400	0.038	3.800
FEL-LIN	0.014	0.638	0.357	1.000	8.400	7.387	0.054	8.400
FEL-FRT	0.153	0.327	0.569	1.000	2.550	2.475	0.067	2.550
CTO-AVI	0.019	0.402	0.586	1.000	2.770	2.632	0.054	2.770
CTO-LEG	0.016	0.535	0.457	1.000	3.492	3.238	0.061	3.492
CTO-VIC	0.216	0.333	0.522	1.000	5.360	5.210	0.072	5.360
MTV-AGN	0.000	0.255	0.745	1.000	2.660	2.606	0.069	2.660
MTV-NAP	0.034	0.194	0.779	1.000	1.540	1.511	0.052	1.540
MTV-SIG	0.535	0.350	0.302	1.000	4.280	4.251	0.327	4.280
MTV-SVI	0.249	0.211	0.593	1.000	1.140	1.123	0.075	1.140
MAM-SCL	0.303	0.304	0.485	1.000	0.830	0.801	0.050	0.830
MAM-UHE	0.108	0.477	0.466	1.000	3.000	2.779	0.048	3.000
MAM-WEA	0.024	0.310	0.673	1.000	3.400	3.325	0.083	3.400
MAM-LAK	0.113	0.467	0.473	1.000	5.380	5.026	0.052	5.380
MAM-KEF	0.134	0.211	0.684	1.000	1.170	1.153	0.077	1.170
H&M-MLD	0.055	0.508	0.465	1.000	5.810	5.423	0.060	5.810
MAM-ALC	0.082	0.342	0.604	1.000	5.780	5.568	0.057	5.780
MAM-BEN	0.158	0.500	0.421	1.000	4.770	4.462	0.060	4.770
MAM-HAR	0.377	0.	0.623	1.000	0.520	0.520	0.087	0.520
MAM-EDZ	0.323	0.550	0.304	1.000	0.790	0.744	0.083	0.790
MAM-LDY	0.470	0.538	0.245	1.000	0.280	0.251	0.042	0.280
H&M-LON	0.000	0.491	0.509	1.000	6.159	5.814	0.068	6.159
HIN-CHI	0.188	0.402	0.485	1.000	3.270	3.133	0.064	3.270
HIN-CRO	0.167	0.554	0.372	1.000	1.720	1.570	0.054	1.720
HIN-BUR	0.085	0.476	0.479	1.000	1.050	1.008	0.092	1.050
HIN-HIW	0.081	0.342	0.605	1.000	3.970	3.862	0.077	3.970
HIN-BAH	0.960	0.200	0.032	1.000	0.430	0.426	0.106	0.430

Figure D-4. Offered Traffic for

As the value of q is decreased to .5 and .3 the offered traffic is seen to decrease almost linearly with respect to q. In Figure D-5 the average calculated offered traffic is plotted versus the quitting probability q and the nearly linear relation is quite apparent. Average offered traffic is seen to vary from slightly over 3 Erlangs for $q =$ 0 to just under 7 Erlangs for $q = 1$ in the case of "user needs". However, for the "network constraint view" average offered traffic is relatively constant with respect to q. This result gives us a good lower bound on offered traffic independent of q. Unfortunately the value of q to use in determining user needs is important. Ideally q could be measured by service observing. However, in the absence of this, study experience would indicate that a value of q around .5 could be used to reasonably approximate human behavior. With few exceptions a value of q in the range of .4 to .8 should provide good results, and depending whether a lower or upper bound is desired appropriate extreme values of q can be used. As an example, one would expect the average offered traffic ("user needs view") to range from 4.7 ($q = .4$) to 6.1 ($q = .8$) from Figure D-5. For the purpose of this report a value of q equalling .5 is used thus providing a result expected to be in mid-range.

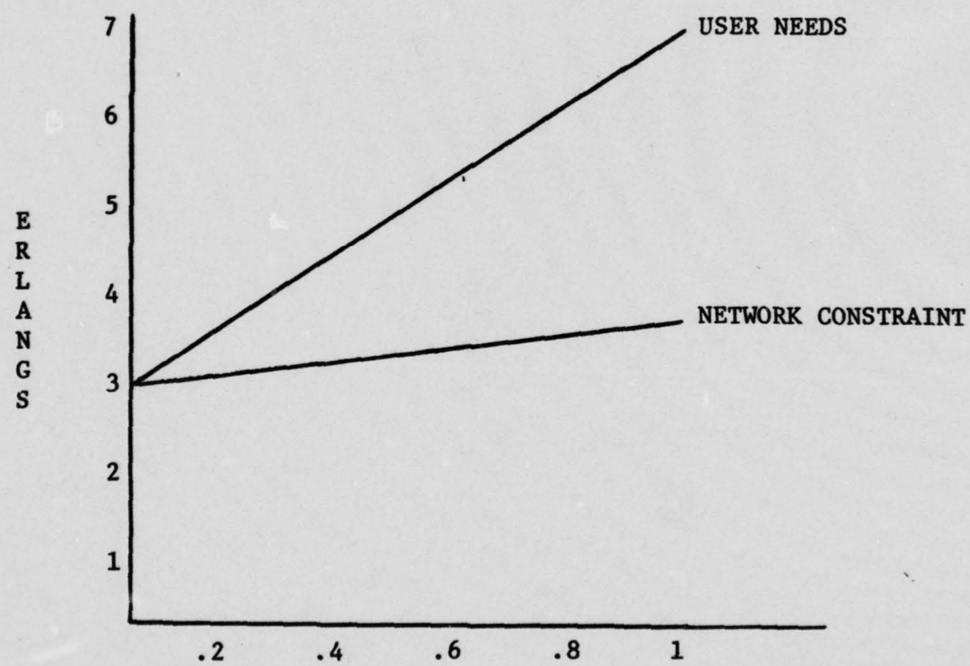
8.0 Observations

Using the model of Section 6 it has been possible to make inferences concerning the offered traffic that is put to the AUTOVON network. By employing the notion of the human factor, called quitting probability, we have been able to correct the results given by the classical theory in order to take into account the effect of reattempts. Strict application of classical methods appears to yield a significant (35%) overstatement of computed offered load.

The computations that have been performed are based solely on data available from the TDCS. The only missing piece of information is the precise value of q. However, by picking reasonable extreme values for q, it has been possible to bound our uncertainty in the computed offered traffic.

Several general observations can be made as a result of our computations. First it is apparent that the users of the network would put through almost twice as much traffic as is currently carried if this were possible. The chief network-dependent reason that traffic is lost is the limited number of access lines to the AUTOVON switches. About 20% of the attempts are blocked for this reason. However, there is about 40% blocking probability associated with subscriber unavailability conditions and announcement trunks. These are obviously the major reasons calls do not go through. To what extent network problems play a role in this blocking probability figure we cannot say. Nevertheless, it is slightly higher than is normally encountered commercially. Precedence levels higher than routine constitute roughly 30% of the traffic on AUTOVON, and the effect of pre-emptions is not quantified. It seems safe to conclude, however, that if all network constraints were removed from AUTOVON the observed traffic would rise to a level above the "network constraint" computations but short of "user needs" —perhaps to an average of over 4

OFFERED TRAFFIC VERSUS QUITTING PROBABILITY



QUITTING PROBABILITY

Figure D-5. Offered Traffic Versus Quitting Probability

Erlangs per base. However, implicit in this calculation is the idea that users do not change their nature in terms of origination rate. If network constraints were removed we would expect additional usage to be generated because users would place more calls due to the better grade of service provided. For this reason we have employed the "user needs" view of offered traffic in our computations and consider this view to be appropriate for network planning purposes.

Appendix D — References

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4. Guernineau, J.P., Pellieux, G 11 Nouveaux resultats concernant le comportement de l'abonne du reseau telephonique de Paris — *Commutation & Electronique*, No. 45, 1974, pp. 53-71.

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Appendix E
GTE Sylvania Traffic Recorder System

1.0 Introduction

The GTE Sylvania traffic recorder system is a special purpose device used to obtain peg count and usage data for non-switched telephone circuits with tone supervision. It was designed to gather data on circuits of interest to the Traffic Flow Study being carried out by GTE Sylvania.

This appendix outlines the basic operational characteristics of the traffic recorder — its input requirements, the type of data recorded, recording algorithm, and the mass storage medium employed.

Section 2 summarizes the input/output characteristics of the device. Section 3 discusses the internal organization and data flow through the recorder, with special emphasis on the microcomputer subsystem. Section 4 describes system physical characteristics, and power requirements.

2.0 Input/Output Characteristics

In broad terms, the traffic recorder as a system takes as input telephone supervisory signalling and converts it into BCD (Binary Coded Decimal) formatted records. This section will first deal with characterizing the input, both in terms of the kinds and amount of data which it can accept, and in terms of electrical interface protocol. Attention will then be turned to the output: the data format, the significance of the data recorded, and the storage medium.

The traffic recorder is capable of monitoring the tone supervision signalling (presence or absence of one tone) on up to ten (10) voice circuits at any given time. The tone detector's center frequency for these circuits are adjustable from 2400 Hz to 2600 Hz. In addition, two voice-band detectors are included in parallel with two of the supervision-tone detectors. The purpose of these voice-band detectors is to provide holding time data on circuits for which the only tone supervision present constitutes the ringing signal. Only the presence of voice/tone is detected — under no condition can the system record message content.

Electrically, each of the tone detectors is designed to bridge a 600 ohm balanced circuit. Under these conditions the detectors introduce less than 0.1 dB loss in signal level, which is well within the limits of normal operation. The signal level which the tone detectors expect to see is −20 dBm. The bandwidth of the tone detectors is set at 5%, and the band pass of the voice detectors is from 500 Hz to 2000 Hz.

As the supervisory signaling and/or presence of voice appears and disappears on a phone circuit, the traffic recorder logic outputs data messages to a digital

magnetic-tape recorder. Each of these messages, generated when the state of the voice/tone detector changes (off/on), is of the following form:

DN HH MM SS

where

D is the current disposition of the detectors: 7-off, 6-on.

N is the detector number in hexadecimal notation: $(0\text{-}B_H) = (0\text{-}11)_{10}$

HH is the two BCD-digit hours entry: 00-24*

MM is the two BCD-digit minutes entry: 00-59

SS is the two BCD-digit seconds entry: 00-59

Using the data recorded in this fashion, on playback one is able to determine not only how often the circuit was being used (peg count), but also holding time for each call (usage). However, it must be noted that accurate interpretation of this data requires a knowledge of the supervisory schemes of the individual telephone circuits under observation.

The data messages are recorded at 1200 baud on a MICROVOX recording wafer, a special continuous-loop recording tape chosen in part for its small dimensions (approximately 1½″ × 2½″ × ⅛″). One 50-foot wafer can hold approximately 8000 data messages, or the equivalent of the signalling from approximately 4000 calls.

Reduction of the data stored on the wafers is accomplished on another system located at the Communication Systems Division of GTE Sylvania, Needham Heights, Massachusetts.

3.0 Internal Organization

The previous section dealt with the traffic recorder as it relates to its environment. In this section, the focus will be on how the system functions internally.

The traffic recorder can be broken down into three distinct subsystems — the tone/voice detector hardware, the 2650 microprocessor subsystem, and the MICROVOX recorder. These devices perform, respectively, the following functions: analog information to digital information conversion, aggregation of various digital data into digital messages, and storage of digital messages for later use.

The tone/voice detectors have already been described from the front end, *i.e.*, the telephone circuit interface. Through the use of active IC (integrated circuit) filters and special analog-digital hybrid tone and voice band detector circuits, the

*The hours and minutes entries are relative to time of start-up, which is logged by technicians attending the recorder.

detector bank delivers to the tone-detector/microprocessor interface the required TTL (transistor-transistor logic) compatible signalling: a logical 'one' when tone/voice is present at the input, a logical 'zero' when tone/voice is absent.

The microcomputer subsystem is by far the most complex (and most burdened from a range-of-tasks point of view) of the three. Its main tasks are to scan the tone/voice detectors, decide when the state of a tone/voice detector has changed, and output appropriate data messages. Its secondary tasks include updating the clock digits (a software clock is employed) and managing the output buffer used to output blocks of data to the tape recorder. Figure E-1 is a high-level flow chart for accomplishing the main tasks, with the secondary tasks represented by one or two aggregated blocks for each.

The microcomputer programs resides in 1024 bytes of PROM (Programmable Read Only Memory), and makes use of approximately 1200 bytes of RAM (Random Access Memory) for data buffering. I/O accesses (via the extended read-write instructions of the Signetics 2650 microprocessor) to data latches, from the tone detectors and to the recorder (via the UART, universal asynchronous receiver/transmitter, used to convert 8-bit parallel data to a 1200 baud serial bit stream) effect the data communications links from the tone detectors through to the MICROVOX recorder.

The recorder subsystem electronics handles two types of information — the data itself (either reading or writing), and control signaling. The data format and transmission has already been discussed. The control signaling between the mircoprocessor and recorder is carried out on bi-directional I/O ports. The tape recorder is completely software controlled, relieving the operator of concern for the operation of the tape drive.

Figure E-2 is a block diagram representation of the traffic recorder system.

4.0 Physical Layout/Power Requirements

The traffic recorder is mounted on a standard 19" rack panel. It has a height of 9" and a depth of 19".

The system is configured to operate on a 110 volt, 50 Hz AC power source. The unit will operate without mechanical or electrical malfunction at 110 volts, 60 Hz. However, the internal timing is based on the 50 cycle standard, thus affecting the time computations. If the system is used at 60 Hz, all time entries must be multiplied by 5/6 on playback in order to compensate for this frequency shift.

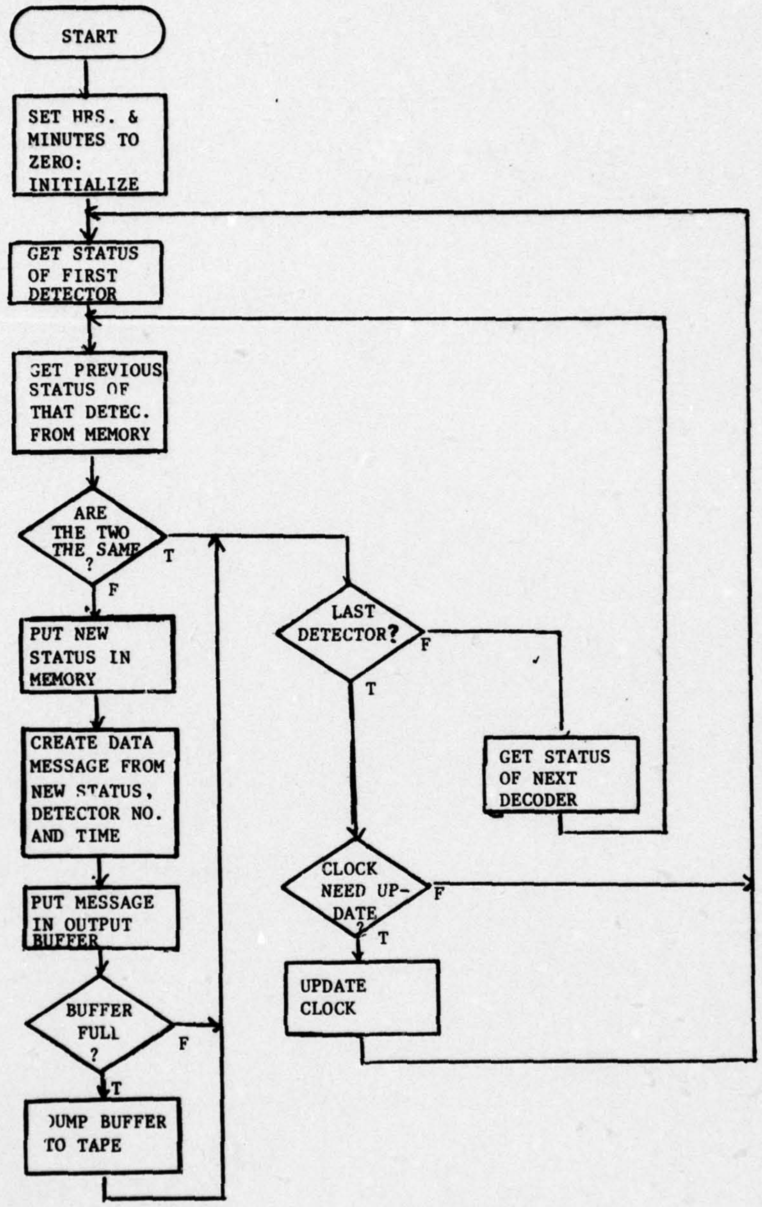

Figure E-1. High Level Flow Chart of Traffic Recorder Program

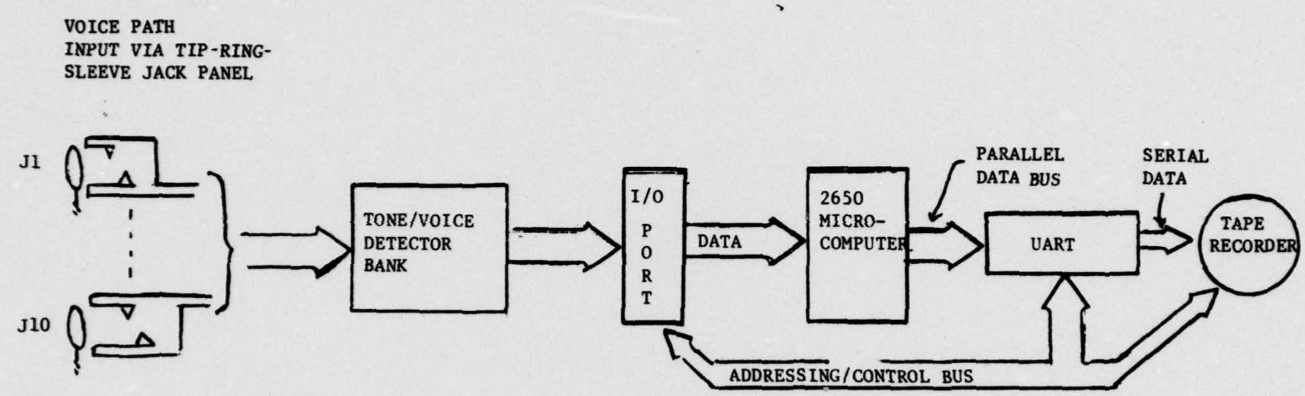

Figure E-2. Traffic Recorder System Block Diagram

Appendix F
Characterization Updating

Traffic flow characterization for the Defense Communications System has been shown to be most effectively represented in three forms. These include :

1. Hundreds-of-call-seconds (CCS) per equivalent Class A telephone
2. Base-to-base traffic flows
3. Traffic flow from Air Force bases to activity-oriented force elements.

The data provided in this report quantifying these aspects of DCS traffic flow must be periodically updated to ensure applicability of the information to then-current DCEC forecasting activities.

Computation of CCS/equivalent Class A telephone requires three sets of information:

1. AUTOVON TDCS Call Data appropriately reduced to determine trunk occupancy and carried traffic from Air Force, Army and Navy installations.
2. Base Traffic Study Reports from the AFCS Northern Communications Area to determine traffic carried by non-AUTOVON systems.
3. Air Force Base Traffic Study Reports, and data from the U.S. Army and Navy to determine the current number of equivalent Class A telephones and the traffic offered to non-AUTOVON systems.

Computation of CCS/equivalent Class A telephone can then be carried out by combining AUTOVON carried traffic together with the non-AUTOVON load to determine total carried traffic. By employing the offered/carried traffic relationship derived in this study, total offered traffic can be computed. Division of this factor on a per-base basis by the number of equivalent Class A telephones will provide the desired CCS/equivalent Class A telephone figure.

Base-to-base traffic flow can be determined for the AUTOVON through the use of the Traffic Data Collection System. Reduction of TDCS Call Data on a per-base basis will provide the desired information. Reduction computer programs must contain the ability to collect and translate called number station codes ("NNX") to determine traffic destination. A similar process is required for U.S. Army service observing data (VAM) to determine the base-to-base traffic flow for the Army DDD system.

Air Force base to force element traffic flow requires two principal sets of data for determination:

1. AUTOVON TDCS Call Data
2. A consolidated Air Force AUTOVON telephone directory.

TDCS Call Data is merged with the consolidated directory and reports generated to describe the flow of traffic from each desired Air Force installation. The consolidated directory must be current with respect to the TDCS data to ensure accuracy of the final data.

Computation of CCS/equivalent Class A telephone is recommended as the principal set of data to be obtained on a routine basis with the remaining information types to be calculated as the need demands. European factors should be reviewed on a quarterly or semi-annual basis.

When TDCS data can be obtained from the Mt. Pateras, AUTOVON TDCS, CCS factors should be determined for Greek and Turkish installations. CCS factors for the Pacific area should be determined to provide a world wide set of forecasting information for the DCS.

Data for the U.S. Army is required but additional information will be needed describing the DDD in Germany. These data, to be provided from an improved VAM equipment, must be translated to an offered traffic form.

Appendix G
Air Force Consolidated Telephone Directory

1.0 Introduction
The Consolidated Air Force Telephone Directory was created to develop the USAF force element models. The European Communications Area obtained copies of base telephone directories from each USAF base in Europe. Since the Directory was to be used to expand the data fields in the TDCS Call Data for each telephone call, final editing and development was performed using an interactive editing program. This appendix will briefly describe the process used.

2.0 Initial Development
The individual base telephone directories obtained by ECA were examined and compared with the DCA provided AUTOVON Master Subscriber and Trunk Group Identification Tables to sort them into those with and those without direct AUTOVON in-dial capability. All telephone numbers capable of being directly dialed by other AUTOVON users were then key punched, with the phone subscribers identification. It was noted that many entries were duplicated in the Organization Section and in the Classified Section of the directories. It was therefore necessary to sort the Consolidated Directory by phone numbers to eliminate duplicates. However, the Organization Section grouped subscribers by force element, which would greatly simplify the assignment of force element codes. The solution was to assign a sequence number to each card in the call deck.

3.0 Initial Editing
The card deck was transferred to magnetic tape and sorted by telephone number. An interactive program was developed to allow the user to edit the Directory. The commands available are shown in Table G-1. Using only the DUPL, DELE, SAVE and STOP commands, all duplicates were eliminated from the Directory which was then resorted by sequence number and printed out.

4.0 Force Element Coding
The printout obtained in Section 3 was annotated by adding four-digit Force Element Codes (designating mission function) and character location codes to each telephone number. The interactive program was then used to add these two codes to each entry in the Directory.

5.0 Final Editing
The final step was to insert into the Directory the telephone numbers, location and force-element codes for all PBX Operators and 4-wire subscribers in Europe, which had been prepared separately. The result was then sorted by telephone number and was ready to be used to merge force element and location information into the TDCS Call Data.

Table G-1
Editing Commands

Commands (* indicates user is prompted for any input)	
ADVN	Skip forward n lines in the directory.*
BASE	Set a new base identifier.*
(CR)	The current line receives the same force element as the previous one.
DELE	Delete this line from the directory.
DUPL	Find all multiple occurrences of phone numbers and prompt user for action to be taken (*i.e.*, if a duplicate should be deleted or not). Directory is assumed to be sorted by phone number.
FIND	Find the first occurrence of a specific force element base identifier pair.*
INSR	Insert a new line before the current one.*
REPL	Repeat the current force element and base identifier for n lines.*
SAVE	Save all changes since the last save or since the beginning of the session.
STOP	End of session.

A typical portion of the final consolidated directory is illustrated in Figure 4-2.

A detailed description of directory use as applied to TDCS Call Data records is provided in Appendix A.

Appendix H
AUTOVON System Characteristics

1.0 Introduction

While assessment of AUTOVON system performance was not a goal of the European Traffic Flow Study, such activity became a requirement in the process of determining offered traffic to the European DCS. This study indicated that the European AUTOVON acted as a congested network and that traffic offered to the network substantially exceeded the carried load.

These observations have resulted from a detailed investigation of TDCS data, derived to support offered traffic calculations and to determine related AUTOVON behavior required in other study phases. Appendix D treats the methodology employed to determine offered AUTOVON traffic.

A variety of observations concerning AUTOVON performance have been provided in earlier sections of this Final Report. A number of these factors have been grouped again in this separate Appendix due to their potential application to activities separate from the primary focus of this study.

2.0 Characteristics

2.1 Entering Grade of Service

Grades of service were calculated during the study from TDCS Call Data using the sum of the originating and terminating trunk occupancies for each trunk group. The originating trunk occupancies were increased by an appropriate amount to compensate for the inability of the TDCS to record the dialing time for each call. At Ramstein AFB, this method resulted in a grade of service of P.20 for the routine user. However, "Dial 8" overflow counts taken at the two Ramstein PBXs during the same period yielded an average of 774 unsuccessful attempts to gain an access line during the busy hour. Since only 406 attempts were successful during the busy hour, the grade of service could also be calculated as $774 \div (774 + 406) = P.65$.

This would overstate the grade of service since many of the unsuccessful attempts were repeat attempts by the same individuals. The true figure is probably closer to P.20 than it is to P.65.

2.2 Holding Times

The average holding time of all AUTOVON calls in Europe is 2.8 minutes. However, when looking at holding time distribution, we find that 46 percent of all calls last less than 25 seconds, with an average holding time for these calls of 15 seconds. If all calls lasting less than 25 seconds are eliminated from the data base, the remainder (which we considered completed calls) average 4.8 minutes holding time. Higher precedence calls have a lower percentage of calls lasting less than 25 seconds. About 30 percent of immediate calls for example last less than 25 seconds.

However, over 50.5 percent of immediate calls are placed to CONUS and the competition for limited CONUS transmission facilities introduces congestion leading to short holding time calls at this precedence level.

CONUS calling presents a special case due to this limited CONUS trunking. In looking at the holding times of CONUS calls, it was surprising to see that immediate calls averaged about 3.8 minutes, priority calls averaged 54 seconds and routine calls averaged slightly over 12 minutes. When examined on a time-distributed basis, however, the reason was obvious. The priority user was unsuccessfully competing with immediate users during the "office-hour" overlap period while the routine user was simply returning to his office after working hours (or from his quarters, where permitted) and making his calls to CONUS while the system was "idle".

2.3 PBX Access Lines

In general, PBX access lines are collected in trunk groups of less than ten circuits and are occupied about 33.6 percent of the time with originating calls and 28.1 percent of the time with terminating calls. Over a 60 percent total occupancy on trunk groups with less than ten trunks provides a relatively poor grade of service.

In addition, and of particular interest is the high (60 percent or greater) occupancy of many two-way trunks in the outgoing (AUTOVON) direction. This factor implies that more traffic is being offered to AUTOVON than can be unloaded. Access lines are presently priced to the user on a progressive basis; with one-way incoming lines the least expensive, two-way lines next highest in cost and one-way outgoing lines the most expensive. While this ordering and technique appear appropriate under the network conditions observed during the program, it appears that an additional constraint should be imposed — a specific ratio (2:1 perhaps) of two-way to one-way incoming lines. This would tend to balance the high two-way line outgoing content.

In any case, no particular improvement should be expected from a small change in access line number at any one base. The effects of access line congestion and blockage come into play in attempting to complete a call. Thus improving one base will not have a significant network effect. A comparison in numbers is appropriate here, where a typical commercial installation has about 5-10 times the number of PBX trunks for a population equivalent to a typical European Air Force base. This does not imply that a similar quantity is needed for a base — that decision is a matter of policy and cost — only that to obtain a grade of service comparable to commercial levels, the 8-10 AUTOVON lines at a typical base must be increased far beyond the addition of a few lines, and that this increase must take place simultaneously at many of the larger bases to provide a general improvement.

2.4 PBX Factors

Over 30 percent of all AUTOVON calls terminating at PBXs last less than 25 seconds (assumed incomplete due to no answer, party busy, etc.) while 46 percent of originating calls last less than 25 seconds. This implies that only 16 percent of originated calls are blocked by the AUTOVON.

One base was able to provide peg-counts of incoming AUTOVON calls that reached a PBX busy signal (user instrument busy). Throughout the 24-hour day, 26 percent of all incoming AUTOVON calls reached an instrument busy signal. If true Europe-wide, this would indicate that no matter how many access lines or interswitch trunks were added to the AUTOVON system, no better than a P.26 grade of service could be achieved, user-to-user. One might expect problems such as these to be manifested in the holding time distribution of calls, which is exactly the case.

Many MILDEPT communicators are aware of this overall behavior and the striking impact of PBX performance on call completion rates. A variety of steps have been taken to minimize PBX/user problems. Vigorous, frequent testing of incoming selector banks; the encouragement of people to list only their Class C phone number in telephone directories; and strong interest in a PNID capability are examples of on-going actions.

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TRAFFIC FLOW, PERFORMANCE AND INTERFACE CHARACTERIZATION STUDY --ETC(U)
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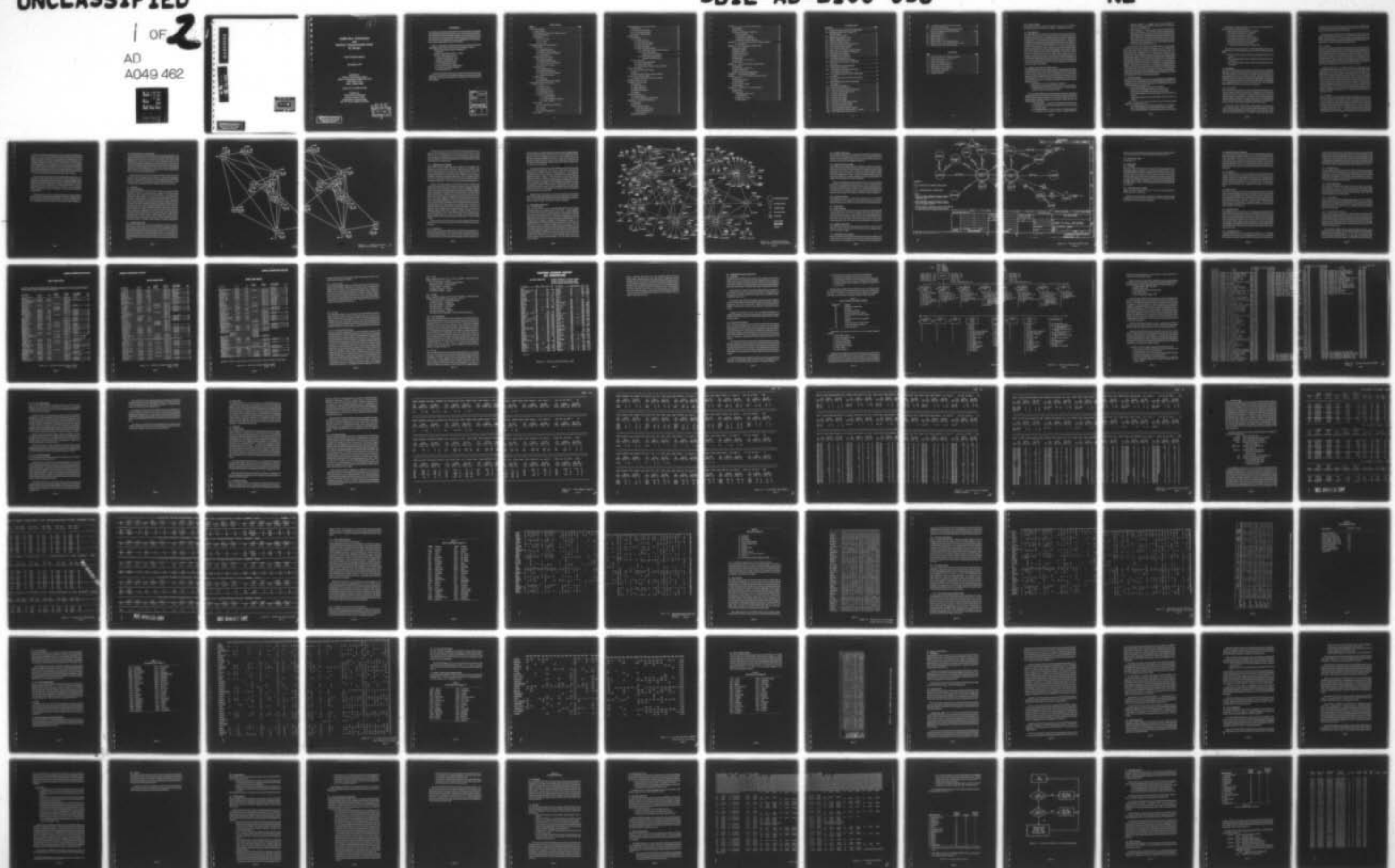

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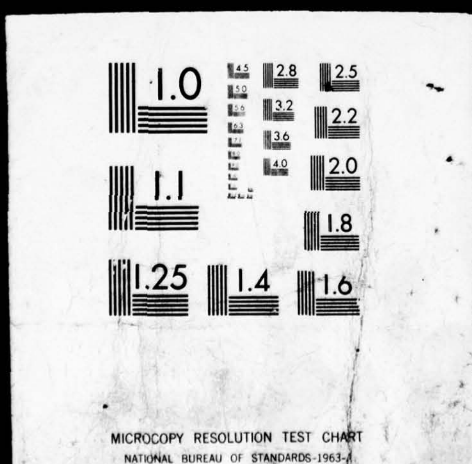

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

6

Traffic Flow, Performance and Interface Characterization Study for Europe

Final Technical Report

18 October 1977

Submitted to:
Defense Communications Agency
Defense Communications Engineering Center
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While is is impossible to list all those who assisted our efforts, the following organizations deserve specific mention for their extraordinary support:

Defense Communications Agency Headquarters
— Operations
Defense Communications Agency — Europe
Air Force Communications Service
— Northern Communications Area
— European Communications Area
— 1964th Communications Group
U.S. Army Fifth Signal Command
— Voice Systems Division, Traffic Branch
U.S. European Command Headquarters
— Communications (J-6)

A common tie among all of these groups and their personnel was their mutual support of an activity that could potentially contribute to their efforts to provide high quality communications within Europe. Our thanks to all who assisted in this study program.

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1.0 Executive Summary

This executive summary is intended to provide a brief overview of the DCEC sponsored European Traffic Flow Study objective, methodology and results.

1.1 Study Objectives

The stated objective of the Traffic Flow, Performance and Interface Characterization Study for Europe was to collect and analyze current common-user voice requirements data and relate it to the DCEC requirements projection methodology to support DCA system planning and engineering; particularly to support the establishment of switch locations, switch sizes and link sizes of the evolving DCS as specified in the Transition and Long Range Plans. The achievement of this goal required three major areas of effort. The first was to develop and implement a process for characterizing U.S. forces in Europe in such a manner that the resultant force element groupings would be uniquely identifiable and be capable of having their voice traffic measured or derived independently of other force element groups. The second was to measure voice traffic in the European DCS (and, if possible, the non-DCS common user voice systems) which could be applied to the force element stratification developed in the first effort. Third and most important was to conduct analytic efforts to define a process whereby the desired traffic needline estimation capability could be provided through appropriate merging of the results of the first two efforts.

1.2 The Role of the Traffic Data Collection System

The Traffic Data Collection System (TDCS) was becoming operational at European AUTOVON switch sites at the time this study began, in May 1976. This new system provides the DCA with the only currently operational DCS traffic measurement equipment capable of automatically collecting call destination information. It was only through the use of TSCS "Call Data" that calling patterns as well as volumes could be derived. There were a few problems encountered in deriving the requisite information because:

a. The TDCS was new, still containing a few problems.
b. The TDCS was not designed with this specific use as a consideration.
c. Although the basic data reduction program existed, no analytic programs existed to operate on that program's output.

To overcome these difficulties, a substantial amount of effort was expended in cooperation with the DCA in developing a complete process for routine reduction of TDCS Call Data and specific analytic processes required to support the study. The following separate computer programs were developed to operate on TDCS Call Data in support of this study:

a. "Translated Dump" — translates the TDCS generated ASCII characters and produces a formatted dump of the first few records on each file to verify data quality;
b. "Consolidation Program" combines all files on a TDCS magnetic tape into a single file on a new tape for use by the "modified CADAPS";

c. "Modified CADAPS" — a modified version of the DCA/NCA developed CADAPS program which forms the complete "Call Data Records" for each telephone call;

d. "Report Generator" — a general purpose program which generates listings of Call Data Records sorted in any sequence desired using any one through ten of the ten unique data fields in each record and/or four special subsets (of the originating and terminating trunk number, dialed digits or initial time) — additionally special subroutines may be accessed from the main program to prepare statistical summaries, perform calculations and cross-merge files — ten such subroutines have been added to the report generation program.

A separate review of the TDCS and its interaction with its co-located 490L AUTOVON Switch revealed a number of anomalies, only one of which had an impact on this program. Due to the manner in which the TDCS obtains its data, true trunk occupancy for originating calls is not recorded since the dial time is not included. One of the special Report Generator subroutines was modified to adjust the originating occupancy of PBX trunks for the missing dial time by multiplying the number of dialed digits by an average dial time per digit, which was obtained from the Fifth Signal Command. The reason for calculating the true trunk occupancy is that this study required the development of "user needlines" which implies that the telephone "offered traffic" must be known. Unfortunately, the European AUTOVON system is access line limited and the relationship between offered traffic and carried traffic (which the TDCS measures) was not known. In developing the relationship between offered and carried traffic and in developing call patterns, a number of analyses were performed using TDCS Call Data which served to confirm and quantify AUTOVON system operating parameters.

1.3 AUTOVON Statistics

One of the first items to be looked at was average call holding time and holding time distribution. After considerable discussion with knowledgeable European communications personnel, it was determined that any call lasting less than 25 seconds could be considered an incomplete call.

- The average holding time of all calls is 2.8 minutes
- 46 percent of all originating calls last less than 25 seconds
- 30 percent of all terminating calls last less than 25 seconds
- The average holding time of all calls lasting less than 25 seconds is 15 seconds
- The average holding time of all calls lasting 25 seconds or more is 4.2 minutes

Calls to CONUS come under special scrutiny because of the reported great difficulty in completing such a call.

- the average holding time of CONUS Immediate calls is 3.8 minutes
- the average holding time of CONUS Priority calls is 54 seconds
- the average holding time of CONUS Routine calls is about 12 minutes

The destination of calls by precedence was a prelude to the development of call pattern information required for the study.

- 50.5 percent of precedence calls are to CONUS
- 2.3 percent of routine calls are to CONUS
- 16.1 percent of all calls are to CONUS
- 28.6 percent of all calls are precedence calls
- 32.5 percent of precedence calls are to operators
- 40.1 percent of routine calls are to operators
- 37.9 percent of all calls are to operators
- 35.8 percent of operator calls are precedence calls

Directional trunk group occupancies on AUTOVON PBX trunks became a required data entry in the program used to develop offered traffic from carried traffic.

- the average total occupancy of PBX trunks during the busy hour is 61.7 percent
- the average originating occupancy of PBX trunks during the busy hour is 33.6 percent
- the average terminating occupancy of PBX trunks during the busy hour is 28.1 percent

1.4 Study Results

The results of the study differed substantially for the three Services as a result of the differences in their functional missions and in the manner in which they utilize the DCS. Characterizations of force elements and traffic estimation methods were developed for the U.S. Air Force and U.S. Navy forces in Europe and current user needlines on a base-to-base level were established for all three Services (and others) for AUTOVON traffic offerings. In addition, total traffic offering user needlines were established for the U.S. Air Force. (For the U.S. Navy, the AUTOVON base-to-base and Total base-to-base matrices are identical).

1.4.1 U.S. Air Force

The U.S. Air Force in Europe, due to its primary mission of aircraft operations and associated support, requires many fixed bases, all organized in a similar fashion. Air Force base structure was found to be regular enough to establish a basic force element structure at a very fine level. The smallest Air Force organizations that could be considered meaningful in a communications sense, with an independent ability for movement, however, were Wing level organizations, Command Headquarters locations, Combat Support Squadrons and Tactical Groups.

The Air Force relies on AUTOVON for approximately sixty percent of its voice common-user needs, with the remainder being divided among its VF Dial System in the Federal Republic of Germany, ringdown trunks and tie lines. Fortunately, the Northern Communications Area performs periodic base traffic studies

at all major USAF bases in Europe (except in Spain) and these studies provide volume and pattern information on ringdown trunks and tie lines and volume with some pattern information on the VF Dial System.

Thus, generic force element-to-force element and total traffic base-to-base matrices have been developed as well as an AUTOVON base-to-base matrix. For traffic estimation purposes, it was discovered that total long distance busy hour traffic volume could be approximated by multiplying the total number of Class "A" phone lines on a base by 1.7 hundred call-seconds (CCS).

1.4.2 U.S. Navy

Naval forces in Europe are principally comprised of ships at sea which are directed from shore based command locations and maintained at large port facilities. The three major Naval complexes in Europe are in London (CINCUSNAVEUR) and the port facilities at Rota, Spain and Naples, Italy. Other Navy facilities are found in Europe, but of smaller size, and also widely dispersed. In nearly all cases, base organization and the types of units resident on the bases are specifically named, non-repeating types, and are merged in a communications sense in such a manner that generic separation below the base level is neither desirable nor feasible. The force element stratification for the U.S. Navy, then, is the base.

Unlike the other Services, essentially all of the Navy's long distance voice communications needs are served by the AUTOVON system so that the developed AUTOVON busy hour traffic matrix is also the total busy hour traffic matrix. Reflecting the Navy's greater emphasis on the utilization of record traffic systems and its fewer number of locations than the Army or the Air Force, even though all the Navy's voice traffic is carried by AUTOVON. The Navy generates only about 15 percent of the total AUTOVON traffic in Europe. Of that 15 percent, nearly 37 percent represents calls to CONUS while over 25.5 percent is calls directed to non-Navy destinations within Europe. Therefore, less than 6 percent of the total AUTOVON traffic in Europe is between Navy units in Europe. For traffic volume estimation purposes, it was discovered that a good first approximation for Navy PBXs is 1.3 CCS times the number of Class "A" phone lines (nearly 24 percent less than the Air Force).

1.4.3 U.S. Army

The Army represents an entirely different picture than either the Navy or Air Force. First, the Army in Europe is essentially "in garrison" waiting to be called to action or sent on maneuvers. When either of these two conditions occurs, the forces mobilized enter a tactical environment and utilize tactical systems to satisfy their voice requirements in lieu of the DCS. When the Army is in a garrison condition, it is strongly suspected that there is a correlation between the total voice traffic needlines and the number of Class "A" phone lines and/or the number of personnel being supported at a particular location. Unfortunately, the second major differ-

ence prevents confirmation and quantification of the relationship. That difference is that the U.S. Army in Europe is practically entirely contained within the Federal Republic of Germany and utilizes its Direct Distance Dial (DDD) network as its primary common user voice system. The DDD interconnects over 100 Army bases, only fifteen of which have PBX interfaces to AUTOVON. The AUTOVON then is used to obtain CONUS access, provide inter-service and inter-country capabilities and as a DDD backup. Even though the Army has several times the number of personnel in Europe than the other Services, it accounts for only about 31.5 percent of all AUTOVON traffic, nearly 19.5 percent of which is destined for CONUS and over 34.6 percent of which is destined for non-Army bases in Europe.

Only ten traffic measurements capable of yielding traffic patterns have ever been taken on portions of the DDD, nine of which were taken during this study. A sample of nine trunk groups or groups of subscribers out of the entire DDD is totally inadequate to determine traffic patterns of volumes. Utilizing the TDCS, a base-to-base Army busy hour traffic matrix has been developed. However, it must be recognized that the true point of origin and, in many cases, the true destination cannot be determined as calls are "tandemed" into and out of AUTOVON-connected PBXs.

The capability will soon exist to accurately develop both volume and pattern information as GTE Sylvania and the Fifth Signal Command are holding consultations on methods to improve Fifth Signal Command's seven sets of portable service observing equipment and routinely reduce the data produced by these equipments.

2.0 European DoD Voice Communications

There is no single integrated communications system providing common user voice capabilities throughout Europe. The primary DCA managed AUTOVON system is supplemented by the Air Force's VF Dial and the Army's Direct Distance Dial (DDD) Systems in West Germany and by a variety of Ringdown Trunks, tie lines and foreign exchange lines throughout Europe. Each of the primary systems interconnect at individual base Dial Central Offices (DCOs) to permit virtually unlimited connectivity to the knowledgeable user or the user who reaches a knowledgeable operator. However, calls must frequently traverse two or more systems and/or a series of trunks involving multiple operators.

Each of the primary systems will be briefly described and discussed in this Section. It must be recognized that the systems are continuously changing in response to user requirements and that the system configurations provided herein represent a "snapshot" at a single point in time. Substantial changes however, such as the elimination or addition of a DCO or tandem switch are relatively rare.

2.1 AUTOVON

2.1.1 System Description

The primary function of the 490L AUTOVON system is to provide world-wide command and control voice communications capabilities to the DoD. Routine common user traffic is allowed to use the network when it is not being used for command and control purposes. A five level precedence capability (Flash Override, Flash, Immediate, Priority and Routine) is provided to allow more urgent traffic to connect through the network by preempting lower precedence traffic. This is the only voice system connecting DoD forces in Europe with DoD forces in the rest of the world. This connection is provided through CONUS to three gateway AUTOVON switches, located at: Hillingdon, England; Feldberg, West Germany; and Mt. Vergine, Italy. These gateway switches serve their directly connected four-wire subscribers and PBX users as well as connecting to seven other European AUTOVON switches: Martlesham Heath, England; Donnesberg, Langerkopf and Schoenfeld, West Germany; Humosa, Spain; Coltano, Italy; and Mt. Pateras, Greece. See Figure 2-1, which shows the number of 4-Wire subscribers homed on each switch as well as the number of PBXs connected, by Military Department.

2.1.2 MILDEPT Relationships

While the AUTOVON system is under the management of the DCA, the MILDEPTs operate, maintain and use the system and are solely responsible for the end offices and instruments interfacing into the network. The AUTOVON switches at Donnersberg and Coltano are operated and maintained by the U.S. Army under the auspices of the Fifth Signal Command (5th Sig) in Worms, West Germany. The other eight switches are operated and maintained by the U.S. Air Force under the auspices of the European Communications Area (ECA) at Kapaun Barracks, West Germany.

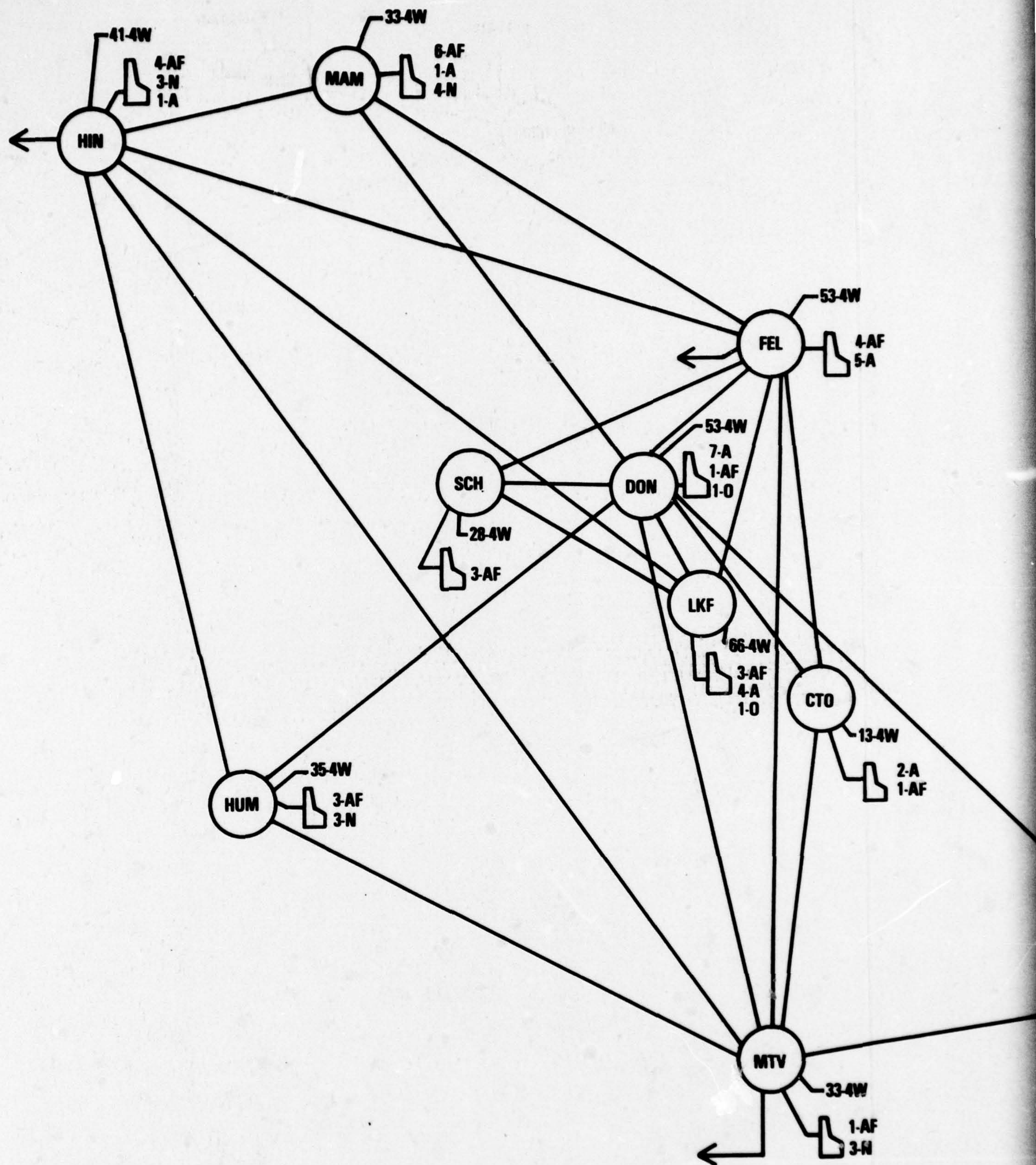


Figure
AUTOVO

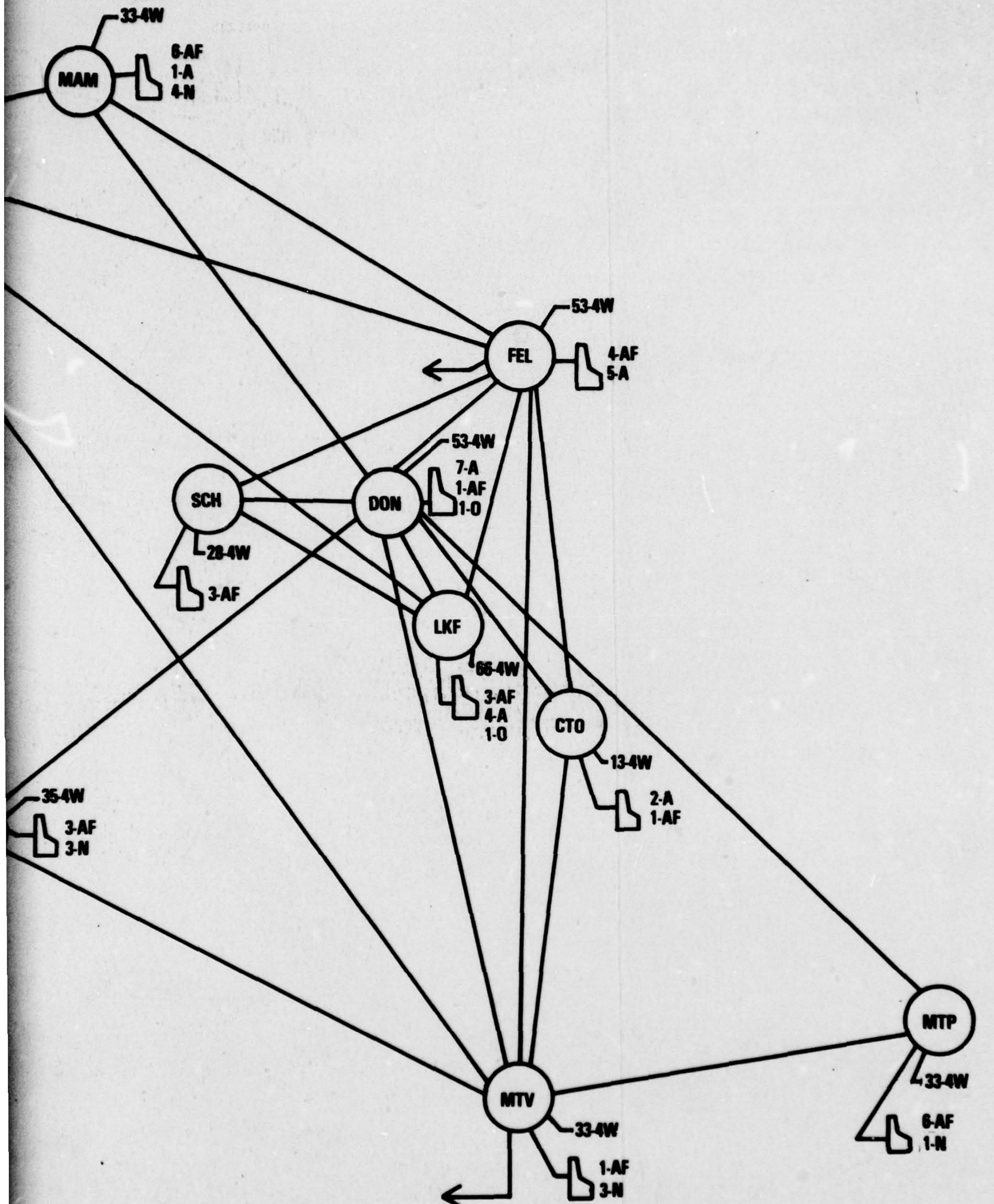


Figure 2-1. Simplified European AUTOVON System Diagram

All of the U.S. Navy and U.S. Air Force PBXs in Europe interface to one or two of the AUTOVON switches while less than twenty percent of the U.S. Army PBXs have an AUTOVON interface. As will be seen in Section 3, the U.S. Navy relies exclusively on AUTOVON for all voice communications in Europe while the Air Force employs AUTOVON for about 60% of its voice needs and the U.S. Army relies primarily on its DDD system.

2.1.3 *Traffic Measurement Capability*

The AUTOVON system traffic measurement capability has, historically, been limited. The recently installed Traffic Data Collection System (TDCS) is now beginning to provide data that can be used in a quantitative manner to accurately assess system performance and perform traffic engineering of the network. A description of the TDCS is provided in Appendix A. There are several restrictions in TDCS use which impact the data collected by that system. In particular is the lack of an answer supervision capability (soon to be corrected) making it difficult to determine call disposition (*i.e.*, answered, user busy, abandoned, preempted, etc.).

A major, two faceted problem is that the TDCS systems are located at the AUTOVON switches proper. They, therefore, are able to record only that traffic which is successful in reaching an AUTOVON switch. To engineer a telephone system, offered traffic is the required piece of information; but the TDCS measures only carried traffic. See Appendix D for the method used to determine offered traffic in AUTOVON, given the carried load. The second concern is that one of the major items of data for access line engineering is directional trunk group occupancy. As presently configured, the TDCS provided actual occupancy on interswitch trunks closely approximates the actual occupancy but fails to record subscriber or user dial time on originated calls, thereby understating that occupancy. The method used in this study assigned an average dial time for rotary-dial users which was added to each call based on the number of dialed digits. This factor was important in study analysis since the congested nature of the system produced inordinate usage of facilities (10% or greater) to handle reattempts. One way to correct this problem, as well as to gain additional information regarding transmission system performance, is to record every change in state on the CCL leads already connected to the TDCS and to integrate that data into the TDCS Call Data records.

On the whole, however, the TDCS, as it is presently configured, provides more useful data on the AUTOVON system than has ever been available on that system in the past.

2.1.4 *Leased Services*

The transmission network that supports the AUTOVON system is generally U.S. owned and operated. However, an increasing percentage of trunking requirements, for the interswitch backbone as well as the access lines, is being leased. This is due to a variety of factors, not the least of which is political in nature. In general, U.S.

owned and operated transmission facilities are nearly saturated. Expansion of those systems requires host nation(s) approval and, in most cases, additional frequency allocations which are withdrawn from the host nation's frequency pool. This approval is becoming more difficult to obtain. As a result, service must be leased from the host nation's telephone company which is generally government owned and operated. Increasingly, these companies do not have capacity available where U.S. Forces' needs are located.

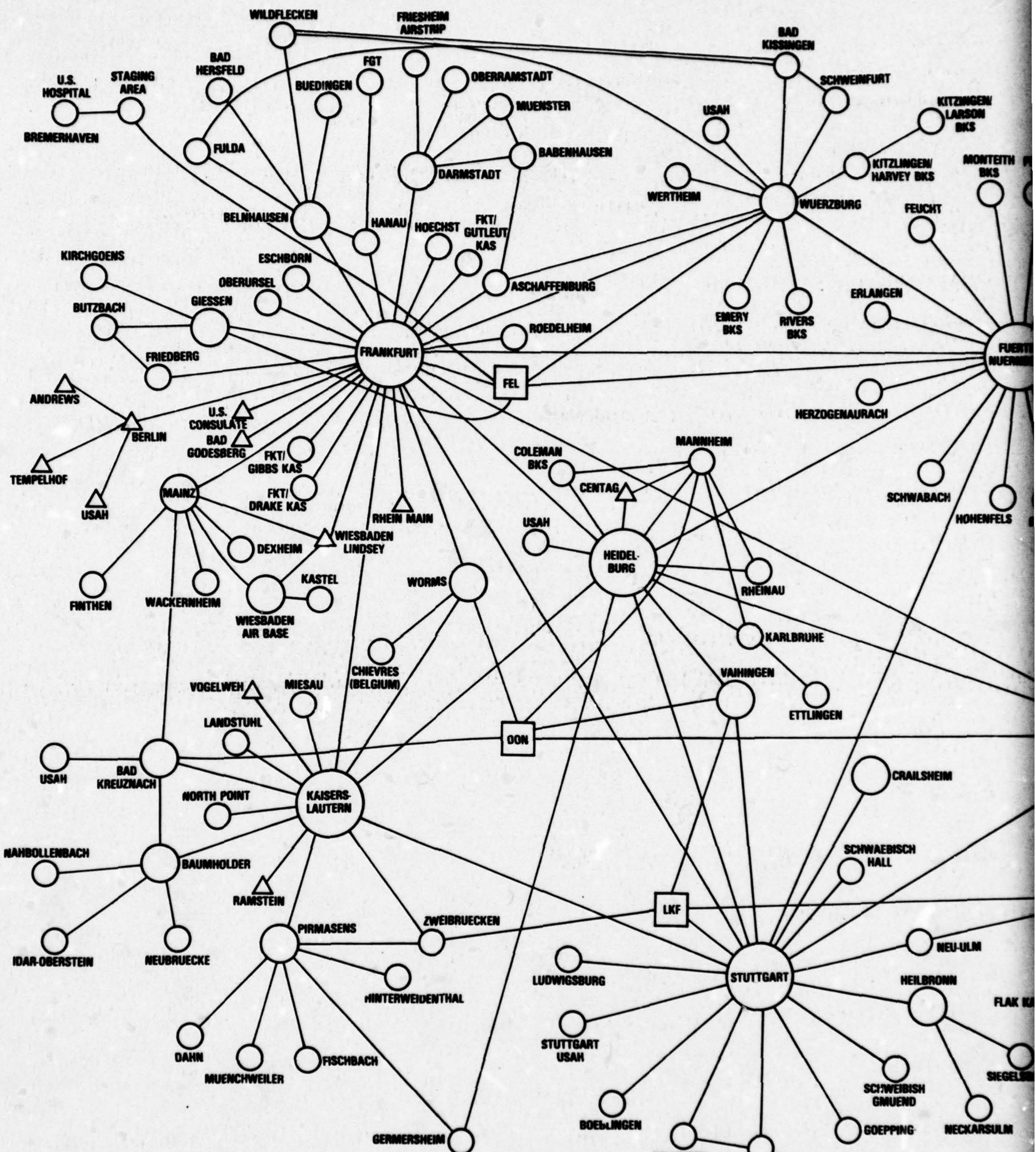
A particular example centers around the Feldberg AUTOVON switch in West Germany. PBX line equipment in West Germany at Schoenfeld, Langerkopf and Donnersberg is essentially saturated, with the addition of a line to one PBX requiring the deletion of a line to another. At Feldberg, there is a surfeit of PBX line equipment. However, both the U.S. DCS transmission system and the Deutsche Bundespost facilities into Feldberg are saturated. The U.S. cannot expand the DCS transmission system nor can it lease additional lines into Feldberg and, as a result, serious consideration is being given to removing PBX line equipment from there and installing it elsewhere in West Germany. Unfortunately, this creates other problems, not the least of which is that this equipment could not be fully utilized elsewhere due to the same transmission system problems and/or the substantially increased leasing costs of access lines.

Additional actions being taken to overcome the limitations on transmission paths include the digital upgrade (DEB program) being implemented to expand the capacity of the DCS European Backbone and the plans being made by all services to replace existing DCOs/PBXs with modern, solid-state equipment.

2.2 Direct Distance Dial System

2.2.1 System Description

This U.S. Army system serves over one hundred PBXs located in West Germany and northern Italy and is commonly known as the "DDD". Another appellation derives from the fact that the overwhelming majority of the equipment comprising the system is of German World War II vintage that was transferred to the United States as part of the reparations. This 30- to 40-year old equipment is extremely difficult and costly to operate and maintain and imposes severe limitations on voice communications capabilities, regardless of call destination. Figure 2.2 is a simplified diagram of the DDD, illustrating the complexity of the network. Six tandem DCOs serve as the major switching centers in the network, located at Nuernberg, Kaiserslautern, Munich, Heidelberg, Stuttgart and Frankfurt. It should be noted that the portions of the DDD serving the Bremerhaven and northern Italy areas are not directly accessible by the rest of the system but must be reached by extending the DDD into AUTOVON and back again. Thus, for any user who does not have direct AUTOVON access, at least two different operators must be involved in placing a single call to Bremerhaven, one of the Army's major staging areas in Europe.


WILDFLECKEN
FRIESHEIM AIRSTRIP
BAD KISSINGEN
BAD HERSFELD
FGT
OBERRAMSTADT
SCHWEINFURT
U.S. HOSPITAL
STAGING AREA
BUEDINGEN
MUENSTER
KITZINGEN/ LARSON BKS
USAH
BREMERHAVEN
FULDA
BABENHAUSEN
DARMSTADT
KITZINGEN/ HARVEY BKS
MONTEITH BKS
WERTHEIM
WUERZBURG
FEUCHT
BELNHAUSEN
HANAU
HOECHST
FKT/ GUTLEUT KAS
KIRCHGOENS
ESCHBORN
OBERURSEL
ASCHAFFENBURG
ERLANGEN
BUTZBACH
GIESSEN
EMERY BKS
RIVERS BKS
ROEDELHEIM
FRIEDBERG
FRANKFURT
FEL
ANDREWS
U.S. CONSULATE
BERLIN
BAD GODESBERG
HERZOGENAURACH
COLEMAN BKS
MANNHEIM
FKT/ GIBBS KAS
TEMPELHOF
CENTAG
MAINZ
FKT/ DRAKE KAS
RHEIN MAIN
SCHWABACH
HOHENFELS
USAH
WIESBADEN LINDSEY
DEXHEIM
USAH
HEIDEL-BURG
KASTEL
WORMS
RHEINAU
FINTHEN
WACKERNHEIM
WIESBADEN AIR BASE
KARLBRUHE
CHIEVRES (BELGIUM)
VAIHINGEN
VOGELWEH
MIESAU
ETTLINGEN
LANDSTUHL
OON
CRAILSHEIM
USAH
BAD KREUZNACH
NORTH POINT
KAISERS-LAUTERN
NAHBOLLENBACH
BAUMHOLDER
SCHWAEBISCH HALL
RAMSTEIN
LKF
ZWEIBRUECKEN
PIRMASENS
IDAR-OBERSTEIN
NEUBRUECKE
NEU-ULM
LUDWIGSBURG
STUTTGART
HINTERWEIDENTHAL
HEILBRONN
STUTTGART USAH
DAHN
FISCHBACH
MUENCHWEILER
SCHWEIBISH GMUEND
BOEBLINGEN
GOEPPING
NECKARSULM
GERMERSHEIM
NELLINGEN
MOEHRINGEN
ECHTERDINGEN

1

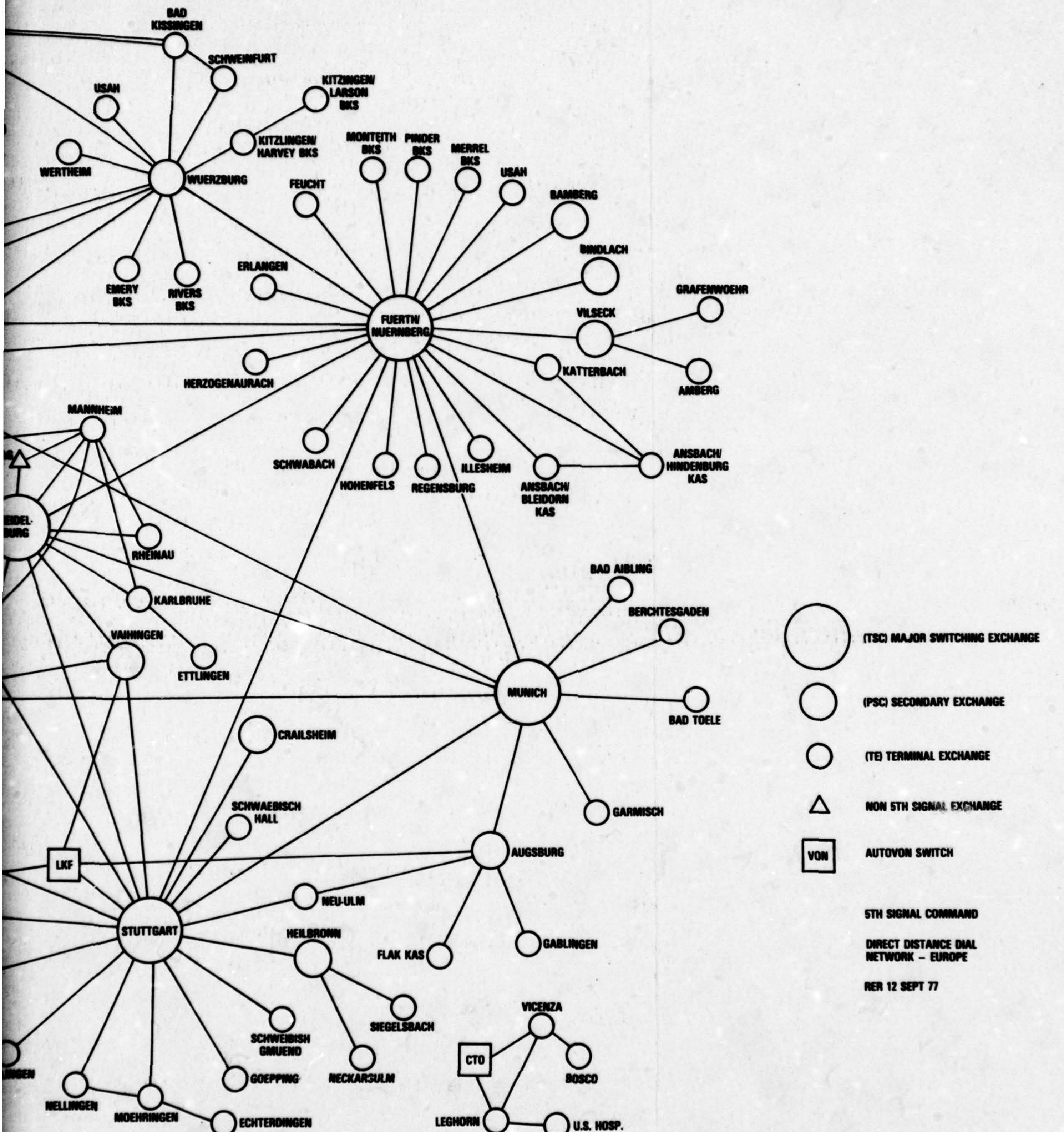


Figure 2-2. Simplified European Direct Distance Dial System Diagram

2

2.2.2 MILDEPT Relationships

The Fifth Signal Command at Worms manages the entire DDD system and the U.S. Army is the primary user of the system. The U.S. Air Force VF Dial System in West Germany ties into the DDD for administrative inter-service traffic, as well as a few other non-Army locations which appear on Figure 2-2.

2.2.3 Traffic Measurement Capability

Until recently, the only traffic measurement capability to support system performance assessment and network engineering consisted of sporadically located peg-count meters and "erlang" meters. The later are modified wattmeters which measure the total power consumed by a group of ten trunks through a standard source and are calibrated in "erlangs" of usage. This method almost always results in the actual trunk group occupancy being understated. The six tandem DCOs are equipped with erlang meters for traffic measurement.

Recently, the Fifth Signal Command was able to procure seven sets of Siemens portable service observing equipment (referred to as "VAMs", from their acronym in German). This equipment was not being used as this study commenced due to a lack of data reduction and analysis support but was employed during the program with GTE Sylvania providing the requisite computer processing capability. The equipment and data analysis undertaken are described in detail in Appendix B.

2.2.4 Leased Service Impact

The comments of Section 2.1.4 on the impact of leased service on AUTOVON apply to the DDD as well. The impact may be even greater, however, as more than one-half the trunking in the DDD system is leased from the Deutsche Bundespost.

2.3 VF Dial System

2.3.1 System Description

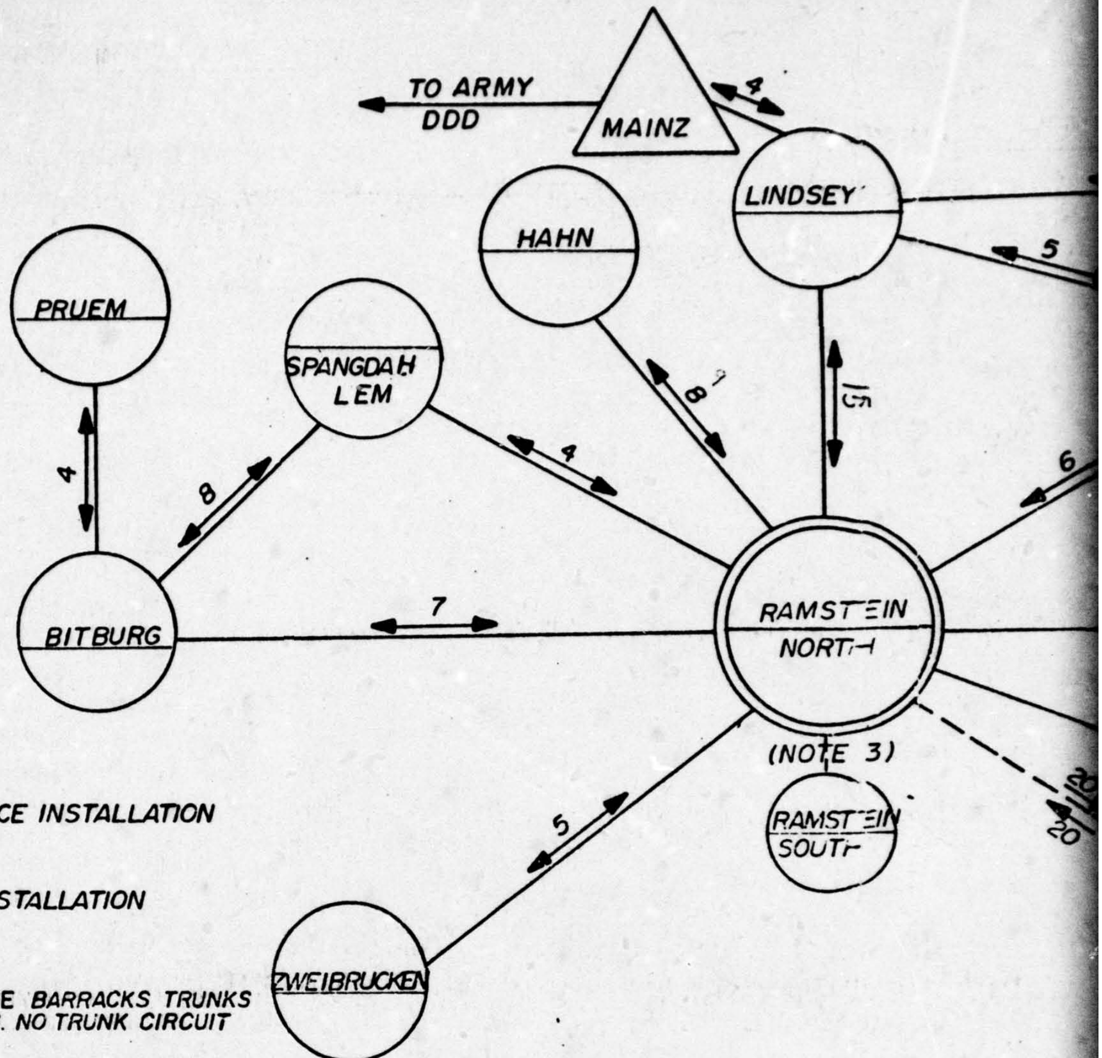
The VF Dial System in West Germany ties the major USAF bases together through a single tandem RP-40 switch located at Ramstein AFB North, and provides for USAF interconnection to the U.S. Army's DDD system. By referring to Figure 2-3, provided by the AFCS Northern Communications Area, the full VF Dial System may be seen. Some links which are part of the VF Dial System do not connect through Ramstein but serve as tie lines accessible through the VF Dial System.

2.3.2 MILDEPT Relationships

The VF Dial System is operated, maintained and used by the U.S. Air Force. Army DDD users, however, may access the VF Dial System by direct dialing for inter-service administrative calling.

2.3.3 Traffic Measurement Capability

There is essentially no permanently installed traffic measurement capability in the VF Dial System. NCA periodically performs studies at the Ramstein RP-40 which provide usage, but not calling pattern of VF Dial trunk groups terminating there.



SYMBOLS:

– INDICATES AIR FORCE INSTALLATION

– INDICATES ARMY INSTALLATION

NOTES:

1. RAMSTEIN-RHEIN ORDNANCE BARRACKS TRUNKS ARE ALL 3-WIRE CIRCUITS. NO TRUNK CIRCUIT EQUIPMENT USED.

2. RHEIN ORDNANCE BARRACKS SERVES KAPAUN WITH A 1212 PAIR SUBSCRIBER CABLE. NO TRUNK CIRCUIT EQUIPMENT USED.

3. RAMSTEIN NORTH - RAMSTEIN SOUTH ARE CONNECTED VIA INTRA BASE CABLE. SOME CIRCUITS ARE 3-WIRE, SOME USE AC RELEASE TRUNK CIRCUITS.

				SYM	NOMENCLATURE
QUANTITY REQUIRED PER DASH NO.					

UNLESS OTHERWISE ... DIMENSIONS ARE ... TOLERANCES
FRACTIONS ± DECIMALS .XX± .XXX±

CURRENT CODE IDENT NO.	NEXT ASSEMBLY	USED ON
	APPLICATION	

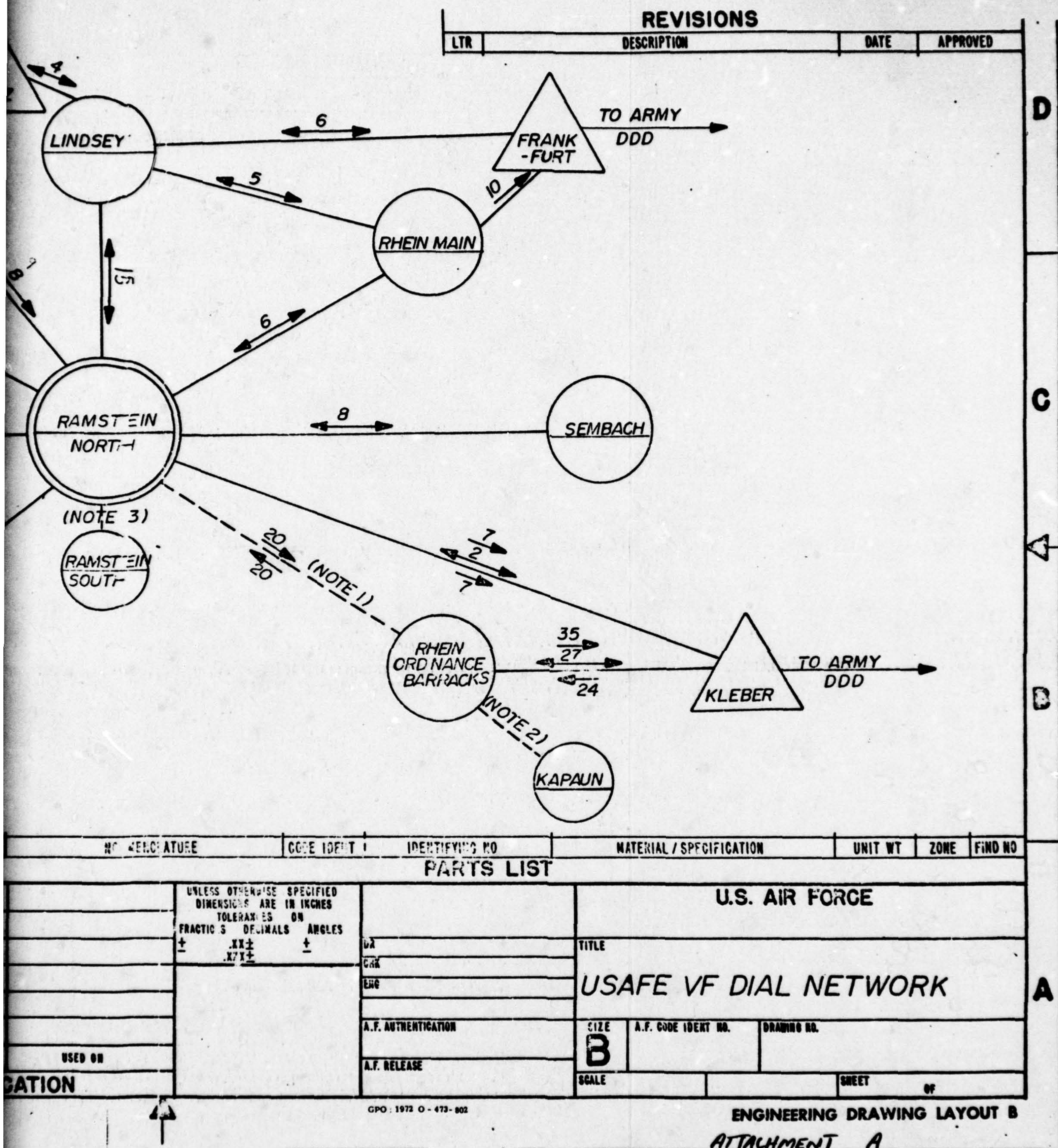


Figure 2-3. European VF Dial System

Studies are also periodically performed at individual bases which provide usage and some pattern data on all VF Dial trunk groups terminating at that base.

2.3.4 Leased Service Impact

See Section 2.2.4.

2.4 Other Circuits

2.4.1 Description

There are a variety of ringdown trunks, tie lines and foreign exchange lines used throughout Europe to facilitate communications outside of the normal AUTOVON/DDD/VF Dial Systems. Trans-Atlantic AUTOVON access lines, in both directions, bypass normal AUTOVON gateway switches and interswitch trunking. Tie lines are used infrequently, primarily between bases in close proximity to each other. Ringdown trunks are used extensively between pairs of bases that have high volumes of traffic. The ringdown "system" has grown haphazardly, and is frequently used to "tandem" calls, involving multiple operators in the placement of a single call.

2.4.2 Traffic Measurement Capability

Usage on tie lines is measured by the U.S. Air Force in the same manner as described for the VF Dial System.

Ringdown trunks and foreign exchange lines are normally measured manually by DSA operators except that NCA obtains data on Air Force ringdown trunks periodically as part of its on-base traffic studies.

3.0 MILDEPT European Organization

U.S. Forces in Europe occupy, or are guests on, bases throughout Western Europe. Without entering into a detailed discussion of U.S. Force and NATO command and control relationships, this section will briefly describe the disposition of U.S. Forces and how they communicate with each other through the voice systems described in Section 2.0. Much voice communications are conducted between units of the same MILDEPT; however, inter-service communications represent a significant portion of the total volume, particularly between bases located in the same host nation.

3.1 U.S. Air Force

The Commander-in-Chief, U.S. Air Force-Europe is located at Ramstein, West Germany, and exercises direct command and control of: Third Air Force, headquartered at Mildenhall, United Kingdom; Sixteenth Air Force headquartered at Torrejon, Spain; and Seventeenth Air Force, headquartered at Sembach, West Germany. In addition, CINCUSAFE exercises direct control over small support groups located at Templehof Airport, Wiesbaden and Lindsey, all in West Germany.

3.1.1 Third Air Force

The Third Air Force Commander exercises command and control over all USAFE forces in the United Kingdom, the major units of which are the 513th Tactical Airlift Wing, also located at Mildenhall; the 10th Tactical Reconnaissance Wing at Alconbury, and the 20th, 48th and 81st Tactical Fighter Wings, located at Upper Heyford, Lakenheath and Bentwaters, respectively. A number of small support groups are located at five RAF standby fields for contingency support. U.S. forces in the United Kingdom are generally located as guests on RAF bases, drawing much of their base support from their hosts.

3.1.2 Sixteenth Air Force

The Sixteenth Air Force Commander exercises command and control of all USAFE forces in Spain, Italy, Greece and Turkey. The commands located in Greece and Turkey have been omitted from this report due to a lack of TDCS data from Mt. Pateras. As in the United Kingdom, USAFE forces in Spain are located on Spanish bases, drawing support from their hosts. The major 16th Air Force units studied were the 401st Tactical Fighter Wing, also located at Torrejon and the 406th Tactical Fighter Training Wing located at Zaragoza, Spain. The remaining USAFE forces studies were the small groups located at the standby airfield at Moron, Spain, and at Aviano, Italy.

3.1.3 Seventeenth Air Force

In general, USAFE forces in West Germany are located on U.S. controlled, stand-alone bases. However, due to the large number of U.S. Army bases located in West Germany, frequently in close proximity to USAFE bases, a variety of inter-

service support agreements have been developed to reduce the costs of providing support services. The major units under the 17th Air Force Commander are: the 322nd Tactical Airlift Wing at Rhein Main; the 26th Tactical Reconnaissance Wing, at Zweibrucken; and the 36th 50th, 52nd, and 86th Tactical Fighter Wings, located at Bitburg, Hahn, Spangdahlem and Ramstein, respectively. In addition, the 32nd Tactical Fighter Squadron at Camp New Amsterdam, Netherlands, and units of the 9th and 12th Air Forces temporarily deployed come under the 17th Air Force.

3.1.4 Non-USAFE Forces

There are a number of USAFE units in Europe which do not fall under the command of CINCUSAFE. The three major groups are: the eight Air Force AUTOVON sites and European Comm Area, which are under AFCS; the large number of USAFSS Support units; and the Military Airlift Support Wing and Squadrons, under MAC. All USAF bases in Europe (except those in Greece and Turkey) have been included in all matrices, regardless of command chain.

3.1.5 USAF Communications

U.S. Air Forces in Europe utilize a number of systems to satisfy voice common-user requirements. The systems available and how they are utilized is quite dependent on the theatre of operations. Non-AUTOVON systems are generally confined to a single country and serve to prevent relatively high volume "local" traffic from further congesting the AUTOVON system.

3.1.5.1 United Kingdom

The U.S. Air Forces in the United Kingdom make rather extensive use of ringdown trunks and tie lines for inter base communications. There is no in-country switched common user system other than AUTOVON. Thus, approximately 51 percent of all traffic is placed into the AUTOVON system, primarily consisting of off-island and/or inter-service traffic.

3.1.5.2 Federal Republic of Germany

The U.S. Air Force voice common-user in West Germany is presented with the widest variety of available communications paths of any U.S. forces in Europe. The VF Dial System not only provides a switched system capability to all major USAF locations in West Germany, but it interconnects into the Army's DDD. Therefore, the user is not necessarily required to use AUTOVON for interservice calls within Germany and may also find that ringdown trunks parallel the VF Dial and AUTOVON for intra-service calls.

One of the best telephone directory General Information Sections, that of Hahn Air Force Base, includes a fairly complete listing of European wide Military Dialing Prefixes for the benefit of Class "A" and "AXC" users located on that base. That listing is presented in Figure 3-1. As may be seen, many locations in West Germany are only accessible through the VF Dial/DDD network, and cannot be

MILITARY DIALING PREFIXES

Each Class "A" (70XX) and Class "AXC" (71XX - 72XX) Hahn telephone subscriber has the capability to DIRECT dial any of the below listed European locations; therefore, <u>no</u> ROUTINE precedence outgoing calls will be processed by the Hahn AB Switchboard unless the direct dialing systems become inoperative.

TEL EXCHANGE	VF DIAL	INFO	AUTOVON DIR DIAL	AUTOVON OPR ASST	FM CIV PHONE INTO MILITARY	INFO
Air Pax Svc R/M Ger	506-7140	113	8-462-7072	8-462-1110	0611-699+	113
Alconbury U K				8-223-1110		
Amberg Ger	507-642+	643-92		8-445-1110	09621-83+	92
Amer Consulate (FKT) Ger	507-310+	311-92		8-444-1110	0611-151-2310+	92
Amer Ebsy (BONN) Ger	507-319+	311-92		8-487-0123		
Amer Ebsy (EUROFE)				8-487-0123		
Ankara Turky			8-672-XXXX	8-672-1110		
Ansbach Ger	507-671+	621-92		8-445-1110	0981-83+	92
Aschaffenburg Ger	507-317+	311-92		8-444-1110	06021-35+	92
Athens Greec			8-662-XXXX	8-662-1110		
Aviano Italy			8-632-XXXX	8-632-1110		
Augsburg Ger	507-581+	92	8-422-XXXX	8-422-1110	0821-4088+	92
Babenhausen Ger	507-373+	311-92		8-444-1110	06073-38+	92
Bad Aibling Ger	507-539+	521-92		8-439-1110	08061-80+	92
Bad Hersfeld Ger	507-363+	311-92		8-444-1110	06621-86+	92
Bad Kissingen Ger	507-329+	92			0971-86+	92
Bad Kreuznach Ger	507-252+	92	8-493-XXXX	8-493-1110	0671-609+	92
Hospital	507-253+	252-92				
Bad Nauheim Ger	507-301+	331-92		8-444-1110	06032-81+	92
Bad Toelz Ger	507-531+	521-92		8-439-1110	08041-30+	92
Bamberg Ger	507-652+	92		8-445-1110	0951-400+	92
Baumholder Ger	507-231+	92		8-494-1110	06783-6+	92
Bentwater U K			8-225-XXXX	8-225-1110		
Berchtesgaden Ger	507-538	521-92		8-439-1110	08652-8+	92
Berlin Ger	507-38+	92	8-442-XXXX	8-422-1110	030-819+	92
Bindlach Ger	507-681	621-92		8-445-1110	09208-83+	92
Bitburg Ger	505+	113	8-455-XXXX	8-455-1110	06561-6+	113
Bockenheim Ger	507-303+	311-92		8-444-1110	0611-151-2303+	92
Boeblingen Ger	507-742+	721-92		8-444-1110	07031-15+	92
Bremen Ger				8-443-1110	0421-363+	
Bremerhaven Ger			8-443-XXXX	8-443-1110	0471-488+	92
Buedingen Ger	507-362+	311-92		8-444-1110	06042-8+	92
Butzbach Ger	507-337+	331-92		8-444-1110	06033-82+	92
Camp Darby Italy			8-633-XXXX	8-633-1110		
Canadian PX (Baden-Baden) Ger					07229-611 (Req EXT Nbr)	
Chicksands U K			8-234-XXXX	8-234-1110		
Chiemsee Ger				8-439-1110	08051-9264 (Req Info)	
Coburg Ger	507-653+	652-92			09561-63+	92
Coleman Bks (MHM)	507-137+	131-92	8-434-XXXX	8-434-1110	0621-730-2137+	
Crailsheim Ger	507-771+	721-92		8-423-1110	07951-115+	92
Croughton U K			8-236-XXXX	8-236-1110		
Dachau Ger	507-537+	521-92		8-439-1110	08131-28+	92
Dahn (Pirmasens)Ger	507-211+	221-92		8-433-1110	06331-86-8587 (Req Info)	
Darmstadt Ger	507-371+	311-92		8-444-1110	06151-69+	92
Air Strip	507-376+	311-92		8-444-1110-	06151-69-6+	
Dexheim Ger	507-352+	351-92		8-472-1110	06133-38+	92
Diyarbekir Turky			8-679-XXXX	8-679-1110		
Drake Kaserne (FKT)	507-314+	311-92		8-444-1110	0611-151-2314+	
Emery Kaserne (WRZ)	507-327+	321-92			0931-35-5+	92
Erlangen Ger	507-631+	621-92		8-445-1110	09131-83+	92
Eschborn Ger	507-306+	311-92		8-444-1110	0611-151-2306+	
Eucom Switch				8-487-0123		
Feucht Ger	507-637+	621-92		8-445-1110	09128-21+	92
Finthen Ger	507-354+	621-92		8-472-1110	06131-469+	92
Fischbach Ger	507-212+	221-92		8-433-1110	06393-294+	92
Flak Kaserne (AUG)	507-582+	581-92		8-422-1110	0621-4088+	92

Figure 3-1. Military Dialing Prefixes (USAF)
(Page 1 of 3)

MILITARY DIALING PREFIXES

TEL EXCHANGE	VF DIAL	INFO	AUTOVON DIR DIAL	AUTOVON OPR ASST	FM CIV PHONE INTO MILITARY	INFO
Frankfurt Ger	507-311+	92	8-444-XXXX	8-444-1110	0611-151+	92
Hospital	507-312+	311-92		8-444-1110	0611-151-2312+	
Friedburg Ger	507-301+	331-92		8-444-1110	06031-81+	92
Fulda Ger	507-364+	311-92		8-444-1110	0661-86+	92
Gablingen Ger	507-583+	92		8-422-1110	0621-4088-3+	92
Garmisch Ger	507-535+	521-92		8-439-1110	06821-50+	92
Gelnhausen Ger	507-361+	311-92		8-444-1110	06051-81+	
Germersheim Ger	507-215+	131-92		8-434-1110	06347-86+	92
Gibbs Kaserne (FKT)	507-312+	311-92		8-444-1110	0611-151-2312+	92
Giessen Ger	507-331+	92		8-444-1110	0641-302+	92
Goeppingen Ger	507-727+	92			07161-15+	92
Grafenwoehr Ger	507-643+	92			09641-83+ -(or 11)	92
Gutleut Kaserne (FKT)	507-307+	311-92		8-444-1110	0611-151-2307+	92
Hahn Ger	509+	113	8-453-XXXX	8-453-1110	06543-5+	113
HAHN GER			8-466-XXXX	8-468-1110		
Hanau Ger	507-309+	311-92		8-444-1110	06181-81+	92
Heidelberg Ger	507-121+	92	8-435-XXXX	8-435-1110	06221-57+	92
Hospital	507-122+	121-92		8-435-1110	06221-57-2122+	92
Heilbronn Ger	507-761+	721-92		8-423-1110	07131-15+	92
Herzo Ger	507-632+	621-92		8-445-1110	09132-83+	92
High Wycombe U K			8-233-XXXX	8-233-1110		
3AF High Wycombe U K				8-239-1110		
Hillington U K				8-231-1311		
Hinterweidenthal Ger	507-211-8251+			8-433-1110	06331-86-8251+	92
Hoechst Ger	507-315+	311-92		8-444-1110	0611-3101+	92
Hof Ger	507-682+	113		8-462-1110	09281-63+	113
Hohenfels Ger	507-634+	92			09472-83+	92
Illesheim Ger	507-633+	621-92		8-445-1110	090841-83+	92
Incirlik Turky			8-676-XXXX	8-676-1110		
Iraklion Crete			8-668-XXXX	8-668-1110		
Istanbul Turky			8-674-XXXX	8-674-1110		
Kaiserslautern Ger	507-221+	92	8-433-XXXX	8-433-1110	0631-86+	92
Karamursel Turky				8-675-1110		
Karlsruhe Ger	507-141+	621-92		8-434-1110	0721-759+	92
Katterbach Ger	507-638+	621-92		8-445-1110	09802-361 or 362+	92
Kelly Bks (STG)	507-731+	721-92		8-439-1110	0711-2590+	92
Kirchgoens Ger	507-333+	331-92		8-444-1110	06033-81+	92
Kitzingen Ger	507-325+	321-92			09321-35+	92
Kronach Ger	507-6534+	652-92			09261-531+	92
Lakenheath U K			8-226-XXXX	8-226-1110		
Landstuhl (hosp) Ger	507-223+	221-92		8-433-1110	06371-86+	92
Leghorn Italy			8-633-XXXX	8-633-1110		
Lindsey AS Ger	501+	113	8-472-XXXX	8-472-1110	06121-8+	113
NOTICE: When calling a LAS 5 digit ext number via AUTOVON, use only the last 4 digits after the prefix.						
London U K			8-235-XXXX	8-235-1110		
Ludwigsburg Ger	507-726+	721-92		8-423-1110	07141-15+	92
Mainz Kastel Ger	501	92		8-472-1110	06131-48+	92
Mannheim Ger	507-131+	92	8-434-XXXX	8-434-1110	0621-730+	92
Merrell Bks (NBG)	507-625+	621-92		8-445-1110	0911-700-5+	92
Miesau Ger	507-222+	221-92		8-433-1110	06372-86+	92
Mildenhall U K			8-238-XXXX	8-238-1110		
Monteith Bks (NBG)	507-624+	621-92		8-445-1110	0911-700-4+	92
Moron Spain			8-722-XXXX	8-722-1110		
Muenchweiler Ger	507-214+	221-92		8-433-1110	06395-6+	92
Muenster (DMT) Ger	507-372+	311-92		8-444-1110	06071-8+	92
Munich Ger	507-521+	92	8-439-XXXX	8-439-1110	089-2521+	92
Murnau Ger	507-534+	521-92		8-439-1110	08841-99+	92
Nahbollenbach Ger	507-234+	231-92			06781-62+	92
Naples Italy			8-625-XXXX	8-625-1110		
Neckarsulm Ger	507-762+	721-92		8-423-1110	07132-15+	92
Nellingen Ger	507-732+	721-92		8-423-1110	0711-3510+	92
Neu Ulm Ger	507-733+	721-92		8-423-1110	0731-72+	92

Figure 3-1. Military Dialing Prefixes (USAF)
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MILITARY DIALING PREFIXES

TEL EXCHANGE	VF DIAL	INFO	AUTOVON DIR DIAL	AUTOVON OPR ASST	FM CIV PHONE INTO MILITARY	INFO
Neubruecke Ger	507-232+	231-92			06762-6+	92
No Point (Weierhof) Ger	507-227+	221-92		8-433-1110	06352-86+	92
Neurnberg Ger	507-621+	92	8-445-XXXX	8-445-1110	0911-700+	92
Hospital	507-622+	621-92		8-445-1110	0911-700-2+	92
Oberammergau Ger	507-533+	521-92		8-439-1110	08822-3+	92
Ober Ramstadt Ger	507-375+	311-92		8-444-1110	06154-34+	92
Oberursel Ger	507-313+	311-92		8-444-1110	06171-6+	92
Offenbach Ger	507-308+	311-92		8-444-1110	0611-151-2308+	
Patch Bks (STG)	507-921+	92	8-428-XXXX	8-428-1110	0711-7301+	92
Pinder Bks (NBG)	507-623+	621-92		6-445-1110	0911-700-3+	92
Pirmasens Ger	507-211+	221-92		8-443-1110	06331-86+	92
Prien Ger				8-439-1110	08051-9264+	92
Preum Ger	507-233+	231-92		8-433-1110	06551-792+	92
Ramstein Ger	5+	113	8-494-XXXX	8-494-1110	06371-47+	113
Regensburg Ger	507-635+	621-92		8-445-1110	0941-700+	92
Rhein Main Ger	506+	113	6-462-XXXX	8-462-1110	0611-699+	113
Flt Svc Ctr	506-6813		8-462-6814			
Rheinau (Tomp Bks) Ger	507-136+	131-92		8-435-1110	0621-730-2136+	
River WHZ Ger	507-324+	321-92			0931-35-4+	92
Roedelheim Ger	507-304+	311-92		8-444-1110	0611-151-2304+	
Rota Spain			8-727-XXXX	8-727-1110		
Rothwestern Ger	507-336+	331-92		8-441-2245	06507-6+	92
Ruesselsheim Ger	507-351+	351-92		8-472-1110	06131-48+	92
SanVito Italy				6-622-1110		
Schwabach Ger	507-636+	621-92		6-445-1110	0922-83+	92
Schwaebisch Gmued (STG)	507-728+	721-92		8-439-1110	07171-15+	92
Schwaebisch Hall (STG)	507-772+	721-92		8-439-1110	0791-45+	92
Schweinfurt Ger	507-323+	321-92		8-428-1110	09721-96+	92
Sembach Ger	503+	113	8-427-XXXX	8-427-1110	06302-7+	113
Sidi Yahia Moroc			8-726-3XXX	6-725-6183		
Sigonella Italy				6-624-1110		
Soesterberg, Holland				8-494-1110	00313404-34222 (Req.ext nbr)	
Spangdahlem Ger	504+	113	8-454-XXXX	8-454-1110	06565-6+	113
Strassburg Kaserne Ger	507-234+	231-92			06781-61+	92
Stuttgart Ger	507-721+	92	6-423-XXXX	6-423-1110	0711-619+	92
Hospital	507-722+	721-92		6-423-1110	0711-54001+	
Tempelhof (BER) Ger	507-38+	92	8-442-XXXX	6-442-1110		
Torrejon Spain			6-723-XXXX	8-723-1110		
Twilight Radio: Athens			8-661-9901			
West Ruislip			8-231-4567			
Wiesbaden			8-441-2267			
Upper Heyford (3AF) U K			8-263-XXXX	8-263-1110		
Vicenza Italy			6-634-XXXX	8-634-1110		
Vilseck Ger	507-641+	643-92				
Vogelweh Ger	507-226+	221-92		6-433-1110	0631-86-6+	92
Wackernheim Ger	507-353+	351-92		6-444-1110	06132-8+	92
Wasserkuppe Ger				8-447-1110		
Wertheim Ger	507-322+	321-92			09342-75+	92
West Ruislip U K			6-233-XXXX	8-233-1110		
Wethersfield U K				8-224-1110		
Wiesbaden Ger	501+	113	8-472-XXXX	6-472-1110	06121-62+	113
NOTICE: When calling a (LAS) 5 digit ext number via AUTOVON, use only the last 4 digits after the prefix.						
Wildflecken Ger	507-365+	329-92			09745-35+	92
Will Bks (MUN) Ger	507-525+	521-92		8-439-1110		
Worms Ger	507-421+	92		8-438-1110	06241-86+	92
Wuerzburg Ger	507-321+	92	8-467-XXXX	8-467-1110	0931-35+	92
Hospital	507-326+	321-92		6-423-1110	0931-35-5+	
Zaragoza Spain			8-724-XXXX	8-724-1110		
Zweibruecken (USA) Ger	507-281+	92	8-426-XXXX	6-426-1110	06332-86+	92
Zweibruecken (USAF) Ger	502+	113	8-425-XXXX	8-425-1110	06332-4221 (Req ext nbr)	

Explanation of symbols: (-) Proceed Dialing, (+) Dial Military Extention Desired, (X) Substitute with Ext Number.

Figure 3-1. Military Dialing Prefixes (USAF)
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reached through AUTOVON. Locations outside West Germany, however, may only be accessed through AUTOVON.

3.1.5.3 Other Countries

As in the United Kingdom, there are no switched common-user systems in use in other European countries. Unlike the U.K., however, there are relatively few ringdown trunks or tie lines in use (except within Turkey). Thus, the majority of common-user voice traffic is placed through the AUTOVON system. Within Turkey, because of the long distance to the nearest AUTOVON switch (Mt. Pateras, Greece), most of the in-country long distance voice traffic is carried by ringdown trunks. Northern Communications Area (NCA) has been unable to perform base communication studies in Spain. Thus, traffic estimates for USAF bases in that country are based entirely on TDCS data.

3.2 U.S. Army

The Commander-in-Chief, U.S. Army-Europe is located at Heidelberg, West Germany, and exercises direct command and control of most U.S. Army forces in Europe. Except for the Army units located at Burtonwood and Harrogate, United Kingdom, and at Vicenza and Leghorn, Italy, all U.S. Army forces in Europe are located in West Germany. The major commanders under CINCUSAREUR are the V Corps Commander in Frankfurt, the VII Corps Commander in Kelley Barracks (Stuttgart) and the 32nd Army Air Defense Command Commander in Darmstadt.

3.2.1 U.S. Army Europe and 7th Army

The major commands reporting directly to CINCUSAREUR (outside of NATO channels) include the USAMMAE headquartered in Zweibrucken, the many Regional Personnel Centers, the USA Medical Command headquartered in Heidelberg, the 4th Transportation Brigade headquartered in Oberursel, the USDESEA headquartered in Karlsruhe, the USA Computer Systems Support Group headquartered in Zweibrucken, the Special Forces Detachment (Airborne) headquartered in Bad Toelz, the U.S. NATO/SHAPE Support Group at SHAPE, the 1st Support Brigade headquartered in Kaiserslautern, the 7th Army Training Center headquartered in Grafenwoehr, the 7th Signal Brigade headquartered at Coleman Barracks (Mannheim), the 15th Military Police Brigade headquartered in Mannheim, the 21st Replacement Battalian in Gutleut Kaserne (Frankfurt), the 56th Field Artillery Brigade headquartered in Schwaebisch-Gmuend, the 59th Ordnance Group headquartered in Pirmasens, the 66th Military Intelligence Group headquartered in Munich and the 24th Engineer Group headquartered in Karlsruhe. Major support commands not under USAREUR include the 5th Signal Command and Communications-Electronics Engineering Installation Agency, both headquartered in Worms and the U.S. Army Engineer Division headquartered in Frankfurt.

3.2.2 V Corps

Major commands reporting to the V Corps Commander in Giessen and their headquartered location are as follows:

3rd Armored Division — Drake Kaserne (Frankfurt)
8th Infantry Division — Bad Kreuznach
V Corps Artillery — Darmstadt
3rd Support Command — Frankfurt
130th Engineer Brigade — Hanau

3.2.3 VII Corps

Major commands reporting to the VII Corps Commander at Kelley Barracks (Stuttgart) and their headquarters locations are as follows:

1st Armored Division — Ansbach/Hindenburg
1st Infantry Division — Goeppingen
2nd Armored Division — Grafenwoehr
3rd Infantry Division — Wuerzburg
VII Corps Artillery — Augsburg
2nd Support Command — Nellingen
2nd Armored Cavalry Regement — Merrell Barracks (Nuernberg)

3.2.4 Army Communications

Army voice communications in Europe are quite similar to those of the Air Force. Outside of West Germany, however, there are only five major Army locations, two in the United Kingdom, two in Italy and one in Belgium. These locations rely on the AUTOVON system to serve their common-user voice requirements, tandeming AUTOVON into the DDD or ringdown trunks in West Germany to reach those locations not directly accessible by AUTOVON. Within West Germany, there are over one hundred Army bases tied together by the DDD, some fifteen of which have direct AUTOVON access. Additionally, some USAF bases in West Germany can be accessed directly through the DDD, tying into the VF Dial System. There are also a substantial number of ringdown trunks between PBX operators. Thus, the primary common user voice system is the DDD, followed by the ringdown and AUTOVON systems. The back page of the 1975 USAREUR telephone book, illustrating DDD access, is shown in Figure 3-2. There have been a number of changes since this book was issued, such as the addition of AUTOVON to Bremerhaven, changes in prefixes, etc.

3.3 U.S. Navy

The Navy ashore in Europe exists primarily to support the ships at sea. As a result, Navy bases are generally port facilities scattered throughout Europe. Shore based Headquarter Commands provide command, control and coordination of the support activities as well as seagoing units. The Commander-in-Chief, U.S. Naval Forces-Europe is headquartered in London, England. Some of the major commands reporting to CINCUSNAVEUR are the commanders of U.S. Navy Activities in London, Rota and Naples, the Commander, Fleet Air Mediterranean in

TELEPHONE EXCHANGE PREFIXES AND ABBREVIATIONS

USE THIS TABLE FOR:

- READY REFERENCE TO AUTOVON PREFIXES
- DIRECT DISTANCE DIAL PREFIXES (DDD)
- LONG DISTANCE INFORMATION PREFIXES

TEL EXCHANGE	ABBREV	AUTOVON	DDD	INFO
AFCENT			•	
Amberg	AMG		2642	2643-92
American Consulate Gen FKT	CON		2310	2310-9
Ansbach (Hindenburg)	ABH		2671	-92
Ansbach (Bleidorn)	ABB		2672	-92
Aschaffenburg	AFG		2317	2311-92
Augsburg	ABG	422	2581	-92
Babenhausen	BHN		2373	2311-92
Bad Aibling	BAI		2539	2521-92
Baden-Baden			•	
Bad Hersfeld	BHD		2363	2311-92
Bad Kissingen	BKI		2328	2321-92
Bad Kreuznach	BKH	493	2252	-92
Bad Kreuznach Hosp	BHH		2253	2252-92
Bad Toelz	BTZ		2531	2521-92
Bamberg	BBG		2652	-92
Baumholder	BHR		2231	-92
Berchtesgaden	BGN		2538	2521-92
Berlin	BLN		238	-92
Bindlach	BDL		2681	2621-92
Bitburg AB	BIT	455	2228-5	2228-113
Boeblingen	BBL		2725	2721-92
Bremerhaven	BUS		•	-92
Brussels	BRN	443	•	
Buedingen	BUD		2362	2311-92
Butzbach	BUT		2337	2331-92
CENTAG (No station announcer)	CEN		2134	-590
Chievres	CHV		2421-5	2421-5-Opr
Coleman (MHM)	COL		2137	2131-92
Crailsheim	CLM		2771	2721-92
Dahn SWBD	DHN		2211-8587	2221-92
Darmstadt	DST		2371	2311-92
Darmstadt Air Strip (Griesheim)	DMT		2376	2311-92
Dexheim	DXM		2352	2351-92
Drake Kaserne (FKT)	DRK		2314	2311-92
Emery Kaserne (WRZ)	ERY		2327	2321-92
Erlangen	ELN		2631	2621-92
Eschborn	EBN		2306	2311-92
Ettlingen	ETN		2142	2131-92
Feucht	FCT		2637	2621-92
Finthen	FIN		2354	2351-92
Fischbach	FIS		2212	2221-92
Flak Kaserne (AUG Hosp)	ABF		2582	2581-92
Frankfurt Hosp (Gibbs Kas)	GBS		2312	2311-92
Frankfurt	FKT	444	2311	-92
Friedberg	FBG		2301	2331-92
Fulda	FDA		2364	2311-92
Gablingen	GBL		2583	2581-92
Garmisch	GAR		2535	2521-92
Gelnhausen	GEL		2361	2311-92
Germersheim	GHM		2163	2121-92
Gibbs Kaserne (FKT Hosp)	GBS		2312	2311-92
Giessen	GSN		2331	-92
Goeppingen	GPN		2731	-92
Grafenwoehr	GFN		2643	-92
Grafenwoehr Swbd	GFO		2643-0	2643-92
Gutleut Kaserne (FKT)	GLT		2307	2311-92
Hanau	HNU		2309	2311-92
Hahn		453		1110
Heidelberg	HDG	435	2121	-92
Heidelberg Hosp	AHH		2122	2121-92
Heilbronn	HBN		2761	2721-92
Herzo Base	HRZ		2632	2621-92
Hinterweidenthal	HWT		2211-8251	2221-92
Hoechst (FKT)	HST		2315	2311-92
Hof AB	HOF	465	2682	113
Hohenfels	HFL		2634	-92
Hohenfels Swbd	HFO		2634-0	2634-92
Idar Oberstein	IDN		2235	2231-92
Illesheim	IHM		2633	2621-92
Kaiserslautern	KLN	433	2221	-92
Karlsruhe	KRE		2141	2131-92
Katterbach	KAT		2638	2621-92
Kelley (SGT)	KLY		2723	2721-92
Kirchgoens	KGN		2333	2331-92
Kitzingen	KTZ		2325	2321-92
Lahr			•	
Landstuhl Med Cen	LDL		2223	2221-92
Lindsey		472		1110
Livorno			•	
Ludwigsburg	LUD		2726	2721-92
Mainz	MNZ		2351	-92
Mannheim	MHN	434	2131	-92
Mehlem (US Embassy)	MLM		2319	2319-0
Merrell Bks (NBG)	MRL		2625	2621-92
Miesau	MIE		2222	2221-92
Monteith Bks (NBG)	MTH		2624	2621-92
Muenchweiler	MWL		2214	2221-92
Muenster (DMT)	MTR		2372	2311-92
Munich	MNH	420	2521	-92
Nahbollenbach	NAH		2234	2231-92
Neckarsulm	NCM		2762	2721-92
Nellingen	NEL		2724	2721-92
Neu Ulm	ULM		2733	2721-92
Neubruecke	NEU		2232	2231-92
North Point (Weierhof)	NPT		2227	2221-92
Nuernberg	NBG	445	2621	-92
Nuernberg Hosp	ANH		2622	2621-92
Ober-Ramstadt	OBR		2376	2311-92
Oberursel	OBL		2313	2311-92
Patch/Vaihingen	VHN	428/432	2921	-92
Pinder Bks (NBG)	PDR		2623	2621-92
Pirmasens	PMS		2211	2221-92
Pruem	PRM		2233	2231-92
Ramstein (USAFE)	RSN	424	2228	113
Regensburg	RGN		2635	2621-92
Rhein Main AB	RMN	462	2305	113
Rheinau	RHN		2136	2131-92
River (Wuerzburg)	RVR		2324	2321-92
Roedelheim (FKT)	RHM		2304	2311-92
Schinnen (Tree beck)	SCN		•	
Schwabach	SWB		2636	2621-92
Schwaebisch-Gmuend	SGD		2732	2721-92
Schwaebisch Hall	SHL		2772	2721-92
Schweinfurt	SFT		2323	2321-92
Sembach	SEH	427	2228-3	2228-113
Shape (Casteau)	CTU		•	
Siegelsbach	SSB		2763	2721-92
Spangdahlem AB	SPM	454	2228-4	2228-113
Stars and Stripes	S&S		2376-741	2311-92
Strassburg	SBK		2235	2231-92
Stuttgart	SGT	423	2721	-92
Stuttgart Hosp	BCT		2722	2721-92
Vaihingen (Patch)	VHN	428/432	2921	-92
Vicenza (SETAF)	VIN		•	
Vilseck	VIL		2641	2643-92
Vogelweh	VOG		2226	2221-92
Wackernheim	WKM		2353	2351-92
Wasserkuppe (AF)		447		1110
Wertheim	WRT		2322	2321-92
Wiesbaden AB	WBN	472	2318	113
Wildflecken	WFL		2365	2328-92
Worms	WMS	438	2421	-92
Wuerzburg	WBG	467	2321	-92
Wuerzburg Hosp	AHW		2328	2321-92
Zweibruecken	ZBN	426	2281	92

• Dial Operator

Figure 3-2. Military Dialing Prefixes (USA)

Naples, Commander, Sixth Fleet at sea, and Commander Mid-East Force on Bahrain Island. Although the Navy has a large number of small units scattered throughout Europe, many of which are communications units, the great majority of Navy personnel are assigned to the London, Rota and Naples complexes. Due to the long distances between shore based units, the Navy has not installed ringdown trunks, etc., but has relied exclusively on AUTOVON to satisfy its long distance voice needs. Many of its access lines involve long distances, such as Bahrain, whose one AUTOVON PBX access line reaches from the Hillindon AUTOVON switch to the Persian Gulf. Within local complexes, such as in London, Rota, and Naples, some tie lines are used.

4.0 The MILDEPT Characterization Process

4.1 Introduction

Characterization of the Military Departments has been considered as that process employed and the results obtained in a division of MILDEPT forces into generic force-elements. Generic force-elements have been defined as some recurring component within a MILDEP that generates sufficient voice traffic to be meaningful for DCA traffic forecasting and is simultaneously capable of independent movement.

These criteria were selected to ensure that traffic models were prepared for those elements which could reasonably affect the Defense Communications System, both in terms of traffic volume and in its ability to move to a different location independent of other forces.

As discussed in the following paragraphs, characterization took a different form for each of the Military Departments due primarily to the mission assigned that organization. The Air Force came closest to fitting the mold of generic force-elements, as defined above, while the Army could not be represented in such a manner.

Although a few elements of the Navy, such as Command Headquarters, are capable of independent movement, the great majority of Navy elements within a base are not and the Navy base has been adopted as the smallest unit which satisfies the above criteria.

4.2 Air Force Characterization

The U.S. Air Force most nearly fits a view that basic categories of forces are found at many locations, and differ primarily in the size of these forces. The Squadron forms a basic unit of Air Force mission-related organization: a collection of Squadrons is then grouped under a Wing; Wings are collected into Numbered Air Forces, all ultimately reporting to USAFE Headquarters. The very nature of the Air Force and its mission produces this type of organization, where aircraft are the principal asset to be supported, requiring fixed bases and associated personnel for this function.

Air Force characterization, starting with the organizational details provided in Section 3, employed Air Force base telephone directories as a key data source with this information appropriately adjusted based upon meetings held with European force representatives. Early in the program, base telephone directories were obtained from 28 Air Force locations in Europe, forming the basis for both characterization efforts and the subsequent force-element traffic flow analysis described in Section 5.

Air Force directories are routinely divided into two sections, an organizational listing and a classified listing. Organizational information is provided in a manner that permits the relationship among base groups to be quickly determined.

A review of these data provided by the directories indicated that:

1. A common base organization was observed in most cases,
2. The presence of aircraft at a base did not disturb the basic organization, but instead added 2-3 classes of forces specifically for aircraft support,
3. A set of eleven force element categories was sufficient to represent any Air Force base.

The force-element categories derived from this data review are listed in Table 4-1. The table indicates major categories of elements, with a more detailed breakdown provided in Figure 4-1. The Category Number indicated was assigned for convenience in later computer processing of telephone traffic information.

Table 4-1
Air Force Primary Force Element Categories

Category No.	Category
01	Headquarters Organization
02	Operations
03	Maintenance (Aircraft)
04	Resources Management (Supply)
05	Combat Support Group (Base Support)
06	Medical
07	Communication Groups or Squadrons
08	Weather
09	USAF Base Operator (within Europe)
10	Tenants and other organizations
4X	4-wire Subscribers

Organizations that were placed within this set of force element categories included:

1. Tactical Fighter Wings
2. Tactical Reconnaissance Wings
3. Tactical Airlift Wings
4. A Tactical Training Wing
5. A Tactical Control Wing
6. Combat Support Squadrons
7. Air Base Groups
8. Air Base Squadrons

Organizations 1 through 4 all include aircraft resident at the base and as a result included force element categories 01xx, 02xx, 03xx and 04xx. The remaining base types usually included some portion of the 04xx category, resources management (or supply) and always encompassed some type of combat support organization (category 05xx) for routine base support. Resident medical, weather and communi-

USAFE
- 0100 - OTHER
- 0101 - LOGISTICS
- 0102 - PERSONNEL
- 0103 - INTELLIGENCE
- 0104 - COMPTROLLER

HEADQUARTERS

TACTICAL CONTROL WG. - 0105
TACTICAL FIGHTER WG. - 0106
TACTICAL AIRLIFT WG. - 0107
TACTICAL RECON. WG. - 0108
TACTICAL TRAINING WG.- 0109

3RD AIR FORCE - 0110
16TH AIR FORCE - 0120
17TH AIR FORCE - 0130
4TH ATAF - 1040
6TH ATAF - 1050
ALLIED AIR FORCES CENTRAL EUROPE - 1060

0201 DEPUTY COMMANDER FOR OPERATIONS
- 0202 TACTICAL FIGHTER SQ.
- 0203 RECON. SQ.
- 0204 AIRLIFT SQ.
- 0205 MEDICAL SQ.
- 0206 TACTICAL CONTROL SQ.
- 0207 TACTICAL AIR SUPPORT SQ.
- 0209 DOT TRAINING
- 0210 OTHERS

0301 DEPUTY COMMANDER FOR MAINTENANCE
- 0302 FIELD MAINT. SQ.
- 0303 ORG. MAINT. SQ. (MAO)
- 0304 AVIONICS MAINT. SQ.
- 0305 MUNITIONS MAINT. SQ. (MAW)
- 0309 TRAINING MGMT. (MAT)
- 0310 OTHERS

0401 DEPUTY COMMANDER FOR RESOURCES MGMT.
- 0402 SUPPLY SQ. (LGS)
- 0403 TRANSPORTATION SQ. (LGT)
- 0404 FUELS (LGSP)
- 0405 AMMO & MUNITIONS SQ.
- 0406 ACCOUNTING & FINANCE (ACF)(AC)
- 0410 OTHERS

0501 COMBAT SUPPORT GROUP
- 0502 CIVIL ENG. SQ. (DE)
- 0503 SECURITY POLICE SQ.
- 0504 PERSONNEL (DP's)
- 0505 SPECIAL SERVICES (S
- 0506 BILLETING & STORES
  EXCHANGE/COMMISSARY
  SERVICES DIVISION (
- 0507 OPERATION & TRAINI
- 0510 OTHERS

0701 COMM. GROUPS OR SQ.

0801 WEATHER

0901 OPERATOR

TENANTS & OTHER ORG.
- 1001 ARMY
- 1002 SAC
- 1003 NAVY
- 1004 OPS
- 1005 AERIAL PORT SQ (OR MASS/MASG)
- 1006 TACTICAL AIRLIFT GROUP
- 1007 RESCUE & RECOVERY SQ.
- 1008 SUPPLY
- 1009 TACTICAL CONTROL
- 1010 OTHERS
- 1011 BOEING
- 1012 DEPENDENT SCHOOLS
- 1013 ECA/NCA
- 1014 BERLIN/ACA/CDR/STAF
- 1015 BERLIN BRIGADE
- 1016 JUSMMAT
- 1017 TUSLOG (HQ)

4-WIRE SU
- 4402
- 4701
- 4901
- 4902
- 4903
- 4904
- 4905
- 4906
- 4907
- 5000
- 9800
- 9900

Figure

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S

- 3RD AIR FORCE - 0110
- 16TH AIR FORCE - 0120
- 17TH AIR FORCE - 0130
- 4TH ATAF - 1040
- 6TH ATAF - 1050
- ALLIED AIR FORCES CENTRAL EUROPE - 1060

DER

- D MAINT. SQ.
- MAINT. SQ. (MAO)
- NICS MAINT. SQ.
- TIONS MAINT. SQ. (MAW)
- NING MGMT. (MAT)
- RS

0401 DEPUTY COMMANDER FOR RESOURCES MGMT.

- 0402 SUPPLY SQ. (LGS)
- 0403 TRANSPORTATION SQ. (LGT)
- 0404 FUELS (LGSP)
- 0405 AMMO & MUNITIONS SQ.
- 0406 ACCOUNTING & FINANCE (ACF)(AC)
- 0410 OTHERS

0501 COMBAT SUPPORT GROUP

- 0502 CIVIL ENG. SQ. (DE)
- 0503 SECURITY POLICE SQ. (SP)
- 0504 PERSONNEL (DP's)
- 0505 SPECIAL SERVICES (SS)
- 0506 BILLETING & STORES (LGV)
  EXCHANGE/COMMISSARY/
  SERVICES DIVISION (SV)
- 0507 OPERATION & TRAINING (OT)
- 0510 OTHERS

0601 MEDICAL

- 0602 BASE HOSPITAL
- 0603 BASE CLINICS
- 0604 WIESBADEN HOSPITAL
- 0610 OTHERS

0901 OPERATOR

TENANTS & OTHER ORG.

- 1001 ARMY
- 1002 SAC
- 1003 NAVY
- 1004 OPS
- 1005 AERIAL PORT SQ (OR MASS/MASG)
- 1006 TACTICAL AIRLIFT GROUP
- 1007 RESCUE & RECOVERY SQ.
- 1008 SUPPLY
- 1009 TACTICAL CONTROL
- 1010 OTHERS
- 1011 BOEING
- 1012 DEPENDENT SCHOOLS
- 1013 ECA/NCA
- 1014 BERLIN/ACA/CDR/STAF
- 1015 BERLIN BRIGADE
- 1016 JUSMMAT
- 1017 TUSLOG (HQ)

4-WIRE SUBSCRIBERS

- 4402 AIR FORCE TUSLOG 4W/PBXs
- 4701 AIR FORCE COMM/ECA/VON SITES/ AIR COMMSTA/AERO STAs
- 4901 AIR FORCE SECGRU/SECURE VOICE// NSA//NCA
- 4902 ARMY 4W/TUSLOG/SECURE VOICE
- 4903 NAVY 4W/SECURE VOICE
- 4904 NATO//CINCEUR//EUCOM//ERS//SILK PURSE
- 4905 DCA-EUR/DECCO/ATEC/NICSMA
- 4906 SAC
- 4907 EMBASSY/STATE DEPT.
- 5000 McGUIRE/SCOTT
- 9800 CONUS
- 9900 NUMBERS NOT IN DIRECTORY

Figure 4-1. USAF Force Element Codes

2

cations groups generally appeared at most locations, at least in the form of a separate and distinct telephone number.

Figure 4-1 indicates a number of force elements that were separately defined to determine if they in fact produced substantial traffic volume unaffected by associated elements. Included among these separately defined elements were:

1. Training-categories 0209, 0309, 0507
2. Weather-category 0801
3. The Wiesbaden AF Hospital-category 0604
4. Fuels-category 0404
5. Ammo and Munitions-category 0405

The result of this examination and grouping was an ability to annotate all Air Force base directories that had an inward dial access from the AUTOVON. This effort was accomplished employing an interactive computer program as described in Appendix G. This task resulted in a unique output from a communications standpoint, a consolidated European Air Force AUTOVON telephone directory, with an automated ability to keep the directory updated with only modest effort. A sample page from this directory is provided in Figure 4-2 indicating the assigned force element categories for a portion of a base with associated organization name, location and telephone number. As discussed in Section 5, these data from the directory are later merged with Call Data from the AUTOVON TDCS to form a complete listing of all calls made by a base and the base and force element category to which they were placed.

To assist in data reduction efforts, two artific l categories were defined as described in Section 5. These provided for calls to CONUS and calls within Europe that were made to telephone numbers not listed in the consolidated directory.

While analysis of traffic information is discussed in the next section, examination of a typical Wing indicates that Wing elements cannot in fact exist separate from the overall organization. A typical squadron, for example, only contains about 2% of the total personnel in a Wing. In addition, a squadron cannot exist independently of support organizations and these organizations cannot exist independent of base support. Thus from a pure organizational standpoint, generic force-element appearance below the Wing level appears unlikely.

A summary of this force-element categorization effort indicates that:

1. Air Force bases and their personnel can be easily and routinely divided into separate areas of work or responsibility
2. All Air Force bases will fit within the described categories, with minor exceptions not affecting a view of traffic patterns
3. The Air Force Wing (Fighter, Airlift, Reconnaissance, etc.) appears to be the only significant organization meeting the requirement for independent mobility.

EUROPEAN AUTOVON DIRECTORY

NNX-EXTN	PARTY	FE	BASE
672-2125	TUSLOG DET 26 COUNTERINTELLIGENC	1010	ANK
672-2130	TUSLOG DET 16-1 GROUND SAFETY	1010	ANK
672-2132	TUSLOG DET 26 CRIMINAL INVEST	1010	ANK
672-2134	TUSLOG DET 26 SECRETARY	1010	ANK
672-2135	TUSLOG DET 37 AEROMED EVAC	0603	ANK
672-2137	TUSLOG DET 37 COMDR	0603	ANK
672-2139	TUSLOG DET 26 INTERPRETERS (TURK	1010	ANK
672-2140	JUSMMAT MAILROOM	1016	ANK
672-2184	TUSLOG EMERGENCY ROOM	0603	ANK
672-2190	TUSLOG DET 37 APPOINTMENTS	0603	ANK
672-2195	BOEING INTERNATIONAL SERVICES	1011	ANK
672-2200	TUSLOG DET 26 COMDR	1010	ANK
672-2204	TUSLOG OR JUSMMAT BOEING SERV IN	1011	ANK
672-2205	TUSLOG DET 26 TECH SERV DIV	1010	ANK
672-2207	TUSLOG ASST SUPT SCHOOLS DIST V	1012	ANK
672-2209	CLASS VI STORE	0506	ANK
672-2212	TUSLOG DEP STAFF JUDGE ADVOCATE	1017	ANK
672-2213	TUSLOG HIGH SCHOOL PRINCIPAL	1012	ANK
672-2215	TUSLOG AUTO, WOOD, CERAMIC SHOPS	0505	ANK
672-2217	MAIN GATE (BELGAT)	0503	ANK
672-2220	TUSLOG DET 18 ADMIN/PERS	1010	ANK
672-2229	TUSLOG PUBLICATIONS & FORMS MGMT	1016	ANK
672-2231	TUSLOG DET 16-1 BARRACKS 2003	1010	ANK
672-2235	TUSLOG ELEM SCHOOL COUNSELOR	1012	ANK
672-2237	TUSLOG DET 16-2 MAINT SUPER	1010	ANK
672-2245	TUSLOG ELEM SCHOOL PRINCIPAL	1012	ANK
672-2250	MACHINE REPAIR	0402	ANK
672-2255	TUSLOG BOWLING ALLEY	0505	ANK
672-2257	TUSLOG DET 37 CHIEF CLINICAL SER	0603	ANK
672-2261	TUSLOG DET 16-1 COMDR	1010	ANK
672-2262	TUSLOG DET 16-1 MAINT	1010	ANK
672-2263	TUSLOG DET 16-1 OPERATIONS	1010	ANK
672-2264	TUSLOG DET 16-1 WIDEBAND	1010	ANK
672-2265	TUSLOG DET 16-1 CRYPTO	1010	ANK
672-2267	TUSLOG DET 37 RESOURCE MGMT	0603	ANK
672-2273	TUSLOG AYA CENTER	0505	ANK
672-2274	TUSLOG FISCAL CTRL OFC	0505	ANK
672-2275	TUSLOG ROD & GUN CLUB	0505	ANK
672-2279	TUSLOG DET 37 MEDICAL SUPPLY	0603	ANK
672-2282	TUSLOG ELEM SCH SUPPLY TECH	1012	ANK
672-2283	TUSLOG HQ GRAPHICS	1016	ANK
672-2285	TUSLOG HOST NATION COORD	1012	ANK
672-2287	TUSLOG DET 26 ADMIN DIV	1010	ANK
672-2288	TUSLOG DET 208-2 DEFENSE PROP DI	1008	ANK
672-2291	TUSLOG OR JUSMMAT BOEING SERV IN	1011	ANK
672-3104	TUSLOG OFFICERS CLUB	0505	ANK
672-3105	AIRMAN DINING HALL	0506	ANK
672-3109	TUSLOG DET 37 LABORATORY	0603	ANK
672-3112	TUSLOG CIVIL LAW	1017	ANK
672-3113	TUSLOG ELEM SCH NURSE	1012	ANK
672-3127	TUSLOG DET 48-1 AIR MAIL TERMINA	1010	ANK
672-3129	TUSLOG LGTT COMMERCIAL PASSENGER	0403	ANK
672-3136	TUSLOG DET 37 MEDICAL MAINT	0603	ANK
672-3146	TUSLOG DET 16-1 TECH CONTROL	1010	ANK
672-3155	TUSLOG DET 16-2 COMDR	1010	ANK
672-3157	TUSLOG DET 16-2 TECH CTRL	1010	ANK
672-3165	TUSLOG DET 37 VETERINARY SERV	0603	ANK
672-3176	TUSLOG RECREATION DIRECTOR	0505	ANK

NNX-EXTN	PARTY
672-3185	TUSLOG DET 48-1 CHIE
672-3198	TUSLOG HIGH SCHOOL P
672-3212	TUSLOG DET 37 ENVIRN
672-3227	BARBER SHOP JUSMMAT
672-3232	TUSLOG DET 120 COMDR
672-3256	TUSLOG OR JUSMMAT BO
672-3265	TUSLOG DET 120 DEP C
672-3266	PASSENGER TRAFFIC SP
672-3267	TUSLOG DET 120 ADMIN
672-3277	TUSLOG DET 26 OPER D
672-3282	TUSLOG DET 120 COMMU
672-3283	TUSLOG DET 120 COMMU
672-3290	TUSLOG LIBRARY
672-3294	TUSLOG DET 18 COMDR
672-3296	TUSLOG NCO CLUB
672-3297	TUSLOG DET 37 DENTAL
675-1110	
676-1110	
677-0123	
679-1110	
721-1151	
721-1171	
721-1191	
721-1511	
721-1611	
721-5012	
721-8512	
721-8523	
721-8534	
721-8545	
721-8556	
721-8578	
721-8589	
721-8590	
721-8601	
721-8612	
721-8623	
721-8634	
721-8645	
721-8667	
721-8678	
721-8689	
721-8690	
721-8756	
721-8767	
721-8845	
721-8867	
721-8878	
721-8890	
721-9745	
721-9767	
721-9990	
722-1110	
722-2000	7473 COMBSPTSQ SP D
722-2020	MAB BOEINGCORP SVC S
722-2030	7473 COMBSPTSQ COMM
722-2031	7473 COMBSPTSQ COMM
722-2045	MAB BOEINGCORP RECE

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Fi

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	FE	BASE	NNX-EXTN	PARTY	FE	BASE
GENC	1010	ANK	672-3185	TUSLOG DET 48-1 CHIEF APO	1010	ANK
Y	1010	ANK	672-3198	TUSLOG HIGH SCHOOL PRINCIPAL	1012	ANK
T	1010	ANK	672-3212	TUSLOG DET 37 ENVIRN HEALTH	0603	ANK
	1010	ANK	672-3227	BARBER SHOP JUSMMAT	0505	ANK
	0603	ANK	672-3232	TUSLOG DET 120 COMDR	1010	ANK
	0603	ANK	672-3256	TUSLOG OR JUSMMAT BOEING SERV IN	1011	ANK
TURK	1010	ANK	672-3265	TUSLOG DET 120 DEP COMDR	1010	ANK
	1016	ANK	672-3266	PASSENGER TRAFFIC SPECIALIST	0403	ANK
	0603	ANK	672-3267	TUSLOG DET 120 ADMIN	1010	ANK
	0603	ANK	672-3277	TUSLOG DET 26 OPER DIV CHIEF	1010	ANK
S	1011	ANK	672-3282	TUSLOG DET 120 COMMUNICATIONS	1010	ANK
	1010	ANK	672-3283	TUSLOG DET 120 COMMUNICATIONS	1010	ANK
RV IN	1011	ANK	672-3290	TUSLOG LIBRARY	0505	ANK
	1010	ANK	672-3294	TUSLOG DET 18 COMDR	1010	ANK
T V	1012	ANK	672-3296	TUSLOG NCO CLUB	0505	ANK
	0506	ANK	672-3297	TUSLOG DET 37 DENTAL CLINIC	0603	ANK
ATE	1017	ANK	675-1110		0901	KAM
	1012	ANK	676-1110		0901	INC
HOPS	0505	ANK	677-0123		4901	ANK
	0503	ANK	679-1110		0901	DIY
	1010	ANK	721-1151		4701	HUM
MGMT	1016	ANK	721-1171		4701	HUM
03	1010	ANK	721-1191		4701	HUM
R	1012	ANK	721-1511		4701	HUM
	1010	ANK	721-1611		4701	HUM
L	1012	ANK	721-5012		4120	TOR
	0402	ANK	721-8512		4701	TOR
	0505	ANK	721-8523		4701	TOR
SER	0603	ANK	721-8534		4903	SAN
	1010	ANK	721-8545		4120	TOR
	1010	ANK	721-8556		4109	ZAR
	1010	ANK	721-8578		4801	TOR
	1010	ANK	721-8589		4201	TOR
	1010	ANK	721-8590		4906	TOR
	0603	ANK	721-8601		4109	ZAR
	0505	ANK	721-8612		4903	ROT
	0505	ANK	721-8623		4903	ROT
	0505	ANK	721-8634		4903	ROT
Y	0603	ANK	721-8645		4903	ROT
	1012	ANK	721-8667		4903	ROT
	1016	ANK	721-8678		5000	MCG
	1012	ANK	721-8689		4403	TOR
	1010	ANK	721-8690		4204	ROT
OP DI	1008	ANK	721-8756		4903	SID
RV IN	1011	ANK	721-8767		4301	TOR
	0505	ANK	721-8845		4403	TOR
	0506	ANK	721-8867		4903	MAQ
	0603	ANK	721-8878		4903	ROT
	1017	ANK	721-8890		4903	ROT
	1012	ANK	721-9745		4903	SAN
RMINA	1010	ANK	721-9767		4120	TOR
ENGER	0403	ANK	721-9990		4204	TOR
	0603	ANK	722-1110		4901	MOR
L	1010	ANK	722-2000	7473 COMBSPTSQ SP DESK SGT	0503	MOR
	1010	ANK	722-2020	MAB BOEINGCORP SVC STA MOTORPOOL	0402	MOR
	1010	ANK	722-2030	7473 COMBSPTSQ COMMISARY OFC	0506	MOR
RV	0603	ANK	722-2031	7473 COMBSPTSQ COMMISARY CHIEF	0506	MOR
	0505	ANK	722-2045	MAB BOEINGCORP RECIEVING STA	0402	MOR

Figure 4-2. Annotated European AUTOVON Directory

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4.3 U.S. Navy Characterization

The U.S. Navy differs radically in organization from the Air Force due to the difference in Navy mission and associated assets. Naval forces are comprised principally of ships at sea which must be directed and maintained from Headquarters locations and port facilities.

In Europe, the Navy is represented at three major locations: USNAVEUR Headquarters in London; and large port facilities at Rota, Spain and Naples, Italy. Each of these locations is occupied by numerous and distinct organizations whose activities are related to some aspect of support or control over ocean froces. For example, the Naples complex includes six Headquarters units under the command of AFSE (Allied Forces Southern Europe). These Headquarters organizations represent such diverse and distinct units as Allied Naval Forces Southern Europe (NAVSOUTH), Submarine Flotilla Eight, Task Force Sixty Four/Sixty Nine/Four Four Two and Naval Striking and Support Forces Southern Europe, as examples.

In effect, generic force-element categories cannot be established for these Headquarters since each element type is highly specialized and unique. However, the majority of Naval forces are inseparable from the bases on which they are located to support the Fleet and the smallest organizational level which can be characterized generically is the base location.

The flow of common-user traffic produced by each of these locations can be determined and the principal communication ties between these bases and other DoD facilities established. Information to support this process is available from the AUTOVON Traffic Data Collection System and is provided in Section 7.

4.4 U.S. Army Characterization

The U.S. Army forms a third unique arrangement of DoD forces and a corresponding special flow of common-user traffic.

Army missions are carried out by troops typically engaged in some tactical activity which can include both training in the form of maneuvers and actual battle. In terms of mission then, communications directly supporting tactical efforts do not appear on the Defense Communications System but instead employ Army tactical systems. While not engaged in mission-related activities, troops are housed in a number of large garrisons: the majority of communications employed under this latter condition is primarily related to routine personnel matters including supply, finance and medical matters. Routine maintenance of equipment also forms a major activity performed during garrison periods.

The result is much the same as with Navy locations: garrisons are large and generally unique, where size and make-up differ as a function of location and the inherent nature of the location. Support facilities are also unique: maintenance locations generally handle only one class of article such as mechanized vehicles, ordnance, etc.

Thus, unlike the Air Force, where Squadrons and Wings can be located and characterized, Army units such as the Brigade, Battalion or Company only exist as a viable communications entity when deployed in the field — at which time they cease to use DCS assets in any significant form.

The majority of Army common-user traffic within Europe is handled by the DDD. As indicated in Sections 3 and 6, the lack of accuracate measurement equipment, the DDD prevents any measurement of carried traffic or prediction of offered traffic within that system. In effect, even if generic force-elements could be derived, corresponding offered traffic data could not be provided at this point in time.

The Army use of AUTOVON can be determined, however, and in the same fashion as described for the Navy, for the basic flow patterns of traffic from major Army garrison locations. These data are provided in Section 6.

5.0 USAF Traffic

As described in Section 4, the USAF in Europe is the only MILDEPT which was capable of being characterized in a strict generic sense. This Section will describe the process used to develop the detailed characterization process and present the final USAF matrices developed. It had been thought that by identifying the called party through the use of analyzed TDCS Call Data, generic force-element to force-element models could be developed. For AUTOVON traffic, this is generally true. However, it was learned that approximately fifty percent of all AUTOVON traffic is dialed to an operator rather than to an identifiable number and that AUTOVON traffic represents only about sixty percent of the total Air Force common-user voice traffic. Thus, only thirty percent of the traffic can be presently identified on a detailed force element basis.

5.1 AUTOVON

5.1.1 TDCS Call Data

At first, attempts were made to utilize DCA produced Call Data records. Problems with that data led to a detailed review of the TDCS and of the data reduction process. It was learned that many calls present in the raw data were rejected by the program that produced the Call Data records for a variety of reasons such as: lack of a termination entry on the originating trunk (even though the terminating entry on the terminating trunk was present); erroneous precedence or route digit (even though the call was completed through AUTOVON); and invalid phone number (according to DCA records, even though the AUTOVON recognized the number and completed the call). DCA provided a listing of the data processing program, which was modified to provide the desired output. In addition, a variety of additional computer programs were prepared for report generation and data analysis. These programs represent a complete process for routine reduction of TDCS Call Data. See Appendix A for more detail on the final process and associated computer software.

As a result of discussions held in Europe, it was determined that personnel frequently placed official calls outside of normal working hours, particularly to CONUS in the evening and that these calls were not recorded during "standard" Call Data collection periods. DCA Operations arranged for special, 24-hour/day, 5-day/week data collections at all operational TDCS sites to support this study.

When the processing of this data on the revised program was completed, the data base contained all originating calls that had been accepted and passed at a particular AUTOVON switch.

5.1.2 Force Element Coding

The U.S. Air Force in Europe was studied from a functional viewpoint with the objective of determining a basis for segregating individual phone numbers by functional groupings based on the listings provided in individual base telephone

directories. Initially, ten major groupings were arrived at: Command Functions, Operations, Maintenance, Resources, Support, Medical, Communications, Weather, Operators and Tenants. Further analysis resulted in the subdivision of the ten categories into more specialized groupings. Code 03, for Maintenance, for example, became: 0301 Deputy Commander for Maintenance; 0302 Field Maintennance; 0303 Organizational Maintenance; 0304 Avionics Maintenance; 0305 Munitions Maintenance; etc. Codes were then added to provide for four-wire AUTOVON subscribers, Army and Navy PBXs, etc. The resulting code number breakout is provided in Figure 4-1.

Each entry in the consolidated telephone directory (see Appendix G) was then examined to determine which force element code should be applied. Fortunately, this process was greatly simplified since the major section of each USAF Base Telephone Directory is the "Organizational Listing" which clusters phone numbers functionally. After adding the four-wire subscribers and all PBX operator numbers, the force-element directory was completed and sorted by telephone number.

5.1.3 Force Element Analysis

The force element coded telephone directory was merged into the TDCS Call Data records so that the Call Data records on each call included both the location code and force-element code of the called number. Four types of runs were then made (see ***Figures 5-1*** through ***5-4***). The first run provides a Force Element Category Summary of all calls originating from a particular base, divided into precedence (PRI) and routine calls (RTN) and destined for a particular Force Element category. The second is a more detailed summary by the full four digit force element code. (Force Element categories 98 and 99 have no further division, being CONUS calls and calls directly dialed to a number in Europe which does not appear in the telephone directory, respectively). The third run provides a Base-to-Force Element Category Summary which is identical to run Number 1 except that each category is divided into the called locations. The three digits appearing in the "Base" column for "98" and "99" category calls are the called telephone number "NNX". For many of the "99" code calls, the base, at least, can be identified and merged into the base-to-base models later. Run Number 4 is the finest grained data summary, giving calls by force element code by location.

These runs provide complete "calling pattern" information, base-to-base and base-to-force element, and an estimate of call completion rates for intra-theatre calls (using 25 seconds as a call completion indicator). The 25 second holding time was determined to be an appropriate separation point between calls that were highly likely to be incompleted (less than 25 seconds) and those that were likely to be completed (greater than or equal to 25 seconds). Discussions with knowledgeable European communications personnel were later confirmed through TDCS holding time distribution analysis.

FORCE ELEMENT CATEGORY SUMMARY FOR SWITCH LKF, PRI, TRUNK 4400, BASE MUNICH , NO. C

FE CATE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CATE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CATE	TOTAL NUMBR	TOTAL PCT	GE NUMB
49	42	88	16	76	99	6	13	5	24				

FORCE ELEMENT CATEGORY SUMMARY FOR SWITCH LKF, RTN, TRUNK 4400, BASE MUNICH , NO. C

FE CATE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CATE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CATE	TOTAL NUMBR	TOTAL PCT	GE NUMB
49	3	20	1	9	99	12	80	10	91				

FORCE ELEMENT CATEGORY SUMMARY FOR SWITCH LKF, PRI, TRUNK 4500, BASE RAMSTIN, NO. C

FE CATE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CATE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CATE	TOTAL NUMBR	TOTAL PCT	GE NUMB
07	10	1	6	1	09	630	44	509	49	10	149	10	1
47	1	0	1	0	49	206	15	124	12	98	315	22	2

FORCE ELEMENT CATEGORY SUMMARY FOR SWITCH LKF, RTN, TRUNK 4500, BASE RAMSTIN, NO. C

FE CATE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CATE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CATE	TOTAL NUMBR	TOTAL PCT	GE NUMB
01	164	3	83	3	02	134	3	80	3	03	307	6	1
05	324	7	172	6	06	71	1	36	1	07	34	1	
09	825	17	542	19	10	886	18	619	22	41	2	0	
46	1	0	1	0	47	45	1	21	1	49	103	2	
98	53	1	36	1	99	1641	33	790	28				

/

F, PRI, TRUNK 4400, BASE MUNICH , NO. CALLS = 48, NO. GE 25S = 21

CI	GE 25S NUMBR	PCT	FE CATE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CATE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT
15	5	24										

F, RTN, TRUNK 4400, BASE MUNICH , NO. CALLS = 15, NO. GE 25S = 11

CI	GE 25S NUMBR	PCT	FE CATE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CATE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT
80	1n	91										

IF, PRI, TRUNK 4500, BASE RAMSTIN, NO. CALLS = 1420, NO. GE 25S = 1048

PCI	GE 25S NUMBR	PCT	FE CATE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CATE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT
44	509	49	10	149	10	119	11	41	7	0	4	0
15	12[illegible]	12	98	315	22	222	21	99	102	7	61	6

KF, RTN, TRUNK 4500, BASE RAMSTIN, NO. CALLS = 4956, NO. GE 25S = 2842

PCI	GE 25S NUMBR	PCT	FE CATE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CATE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT
3	8n	3	03	307	6	185	7	04	349	7	182	6
1	3[illegible]	1	07	34	1	22	1	08	6	0	4	0
18	619	22	41	2	0	0	0	42	1	0	0	0
1	21	1	49	103	2	57	2	50	10	0	3	0
33	79o	28										

Figure 5-1. Force Element Category Summary

2

FORCE ELEMENT CODE SUMMARY FOR SWITCH LKF, PRI, TRUNK 4200, BASE STUTGRT, NO. CALLS =

FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT
0403	1	0	0	0	0901	56	13	54	16	1001	28	7	25	7
4902	12	3	8	2	4904	1	0	0	0	98	275	66	216	64

FORCE ELEMENT CODE SUMMARY FOR SWITCH LKF, RTN, TRUNK 4200, BASE STUTGRT, NO. CALLS =

FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT
0402	1	0	0	0	0403	5	1	3	1	0406	4	1	3	1
0506	1	0	1	0	0901	137	36	93	42	1001	28	7	22	10
1010	16	4	12	5	4701	29	8	24	11	4902	11	3	2	1
4905	4	1	3	1	98	17	4	1	0	99	115	30	46	21

FORCE ELEMENT CODE SUMMARY FOR SWITCH LKF, PRI, TRUNK 4400, BASE MUNICH , NO. CALLS =

FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT
4902	41	85	15	71	4905	1	2	1	5	99	6	13	5	24

FORCE ELEMENT CODE SUMMARY FOR SWITCH LKF, RTN, TRUNK 4400, BASE MUNICH , NO. CALLS =

FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT
4902	3	20	1	9	99	12	80	10	91					

FORCE ELEMENT CODE SUMMARY FOR SWITCH LKF, PRI, TRUNK 4500, BASE RAMSTIN, NO. CALLS =

FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT	FE CODE	TOTAL NUMBR	PCT	GE 25S NUMBR	PCT
0701	10	1	6	1	0901	630	44	509	49	1001	136	10	109	10
1008	1	0	0	0	4106	6	0	3	0	4150	1	0	1	0
4901	42	3	25	2	4902	80	6	37	4	4905	27	2	16	2

TRUNK 4200, BASE STUTGRT, NO. CALLS = 419, NO. GE 25S = 336

GE 25S NUMBR	GE 25S PCT	FE CODE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CODE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT
54	16	1001	28	7	25	7	4701	5	1	5	1
0	0	98	275	66	216	64	99	41	10	28	8

TRUNK 4200, BASE STUTGRT, NO. CALLS = 381, NO. GE 25S = 219

GE 25S NUMBR	GE 25S PCT	FE CODE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CODE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT
3	1	0406	4	1	3	1	0504	11	3	8	4
93	42	1001	28	7	22	10	1003	1	0	0	0
24	11	4902	11	3	2	1	4903	1	0	1	0
1	0	99	115	30	46	21					

TRUNK 4400, BASE MUNICH , NO. CALLS = 48, NO. GE 25S = 21

GE 25S NUMBR	GE 25S PCT	FE CODE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CODE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT
1	5	99	6	13	5	24					

TRUNK 4400, BASE MUNICH , NO. CALLS = 15, NO. GE 25S = 11

GE 25S NUMBR	GE 25S PCT	FE CODE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CODE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT
10	91										

TRUNK 4500, BASE RAMSTIN, NO. CALLS = 1420, NO. GE 25S = 1048

GE 25S NUMBR	GE 25S PCT	FE CODE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT	FE CODE	TOTAL NUMBR	TOTAL PCT	GE 25S NUMBR	GE 25S PCT
509	49	1001	136	10	109	10	1003	12	1	10	1
3	0	4150	1	0	1	0	4701	1	0	1	0
37	4	4903	27	2	16	2	4904	47	3	38	4

Figure 5-2. Force Element Code Summary

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BASE TO BASE-FORCE-ELEMENT-CATE SUMMARY FOR SWITCH LKF, PRI, TRUNK 4400, BASE MUNICH • N

BAS	FE CATE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CATE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CATE	TOTAL NMBR	TOTAL PCT	GE NMBR
BER	49	1	2	1	5	CTO	49	32	67	8	38	FRT	49	1	2	1
VAI	49	1	2	1	5	487	99	1	2	1	5	409	99	3	6	3
633	99	1	2	1	5											

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BASE TO BASE-FORCE-ELEMENT-CATE SUMMARY FOR SWITCH LKF, RIN, TRUNK 4400, BASE MUNICH • N

BAS	FE CATE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CATE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CATE	TOTAL NMBR	TOTAL PCT	GE NMBR
CTO	49	3	20	1	8	220	99	1	7	1	8	421	99	9	60	8
489	99	1	7	1	8											

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BASE TO BASE-FORCE-ELEMENT-CATE SUMMARY FOR SWITCH LKF, PRI, TRUNK 4500, BASE RAMSTIN, N

BAS	FE CATE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CATE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CATE	TOTAL NMBR	TOTAL PCT	GE NMBR
ALC	07	3	0	3	0	TOR	07	6	0	2	0	ZAR	07	1	0	1
ANK	09	10	1	7	1	ATH	09	37	3	32	3	AVI	09	14	1	14
BIT	09	11	1	11	1	CHI	09	8	1	6	1	DIY	09	3	0	2
HIW	09	16	1	16	2	INC	09	115	8	72	7	IKA	09	1	0	0
LAK	09	47	3	43	4	LIN	09	6	0	5	0	MLD	09	33	2	29
RHE	09	2	0	2	0	SEM	09	14	1	12	1	SPA	09	3	0	3
TEM	09	9	1	7	1	TOR	09	74	5	48	5	UHE	09	57	4	51
ZAR	09	46	3	44	4	AGN	10	6	0	6	1	AIH	10	1	0	0
BRE	10	3	0	2	0	CAP	10	2	0	2	0	FRT	10	21	1	20
HEI	10	8	1	6	1	KAI	10	23	2	20	2	LEG	10	7	0	6
MAN	10	21	1	16	2	MUN	10	28	2	18	2	NUR	10	7	0	5
STU	10	3	0	3	0	VIC	10	4	0	4	0	WUR	10	3	0	3
ZWE	10	1	0	1	0	BEN	41	1	0	0	0	HAN	41	3	0	1
SPA	41	2	0	2	0	FEL	47	1	0	1	0	AGN	49	2	0	1
BRU	49	2	0	2	0	CAS	49	1	0	1	0	DUN	49	1	0	1
HEI	49	6	0	4	0	LIN	49	21	1	14	1	LUN	49	7	0	4
NAP	49	24	2	11	1	RAM	49	1	0	1	0	SEM	49	11	1	7
VAI	49	54	4	46	4	221	98	1	0	1	0	223	98	4	0	2
227	98	39	3	22	2	234	98	2	0	0	0	236	98	1	0	1
271	98	5	0	4	0	276	98	1	0	1	0	277	98	1	0	1
347	98	5	0	4	0	352	98	5	0	4	0	364	98	1	0	1
440	98	8	1	7	1	458	98	8	1	8	1	465	98	4	0	2
471	98	1	0	1	0	478	98	7	0	5	0	467	98	34	2	27
633	98	1	0	1	0	638	98	11	1	7	1	685	98	1	0	1
699	98	2	0	2	0	723	98	1	0	1	0	725	98	1	0	1
735	98	5	0	4	0	785	98	1	0	0	0	767	98	7	0	6

ITCH LKF, PRI, TRUNK 4400, BASE MUNICH , NO. CALLS = 48, NO. GE 25S = 21

AL PCT	GE 25S NMBR	PCT	BAS	FE CATE	TOTAL NMBR	PCT	GE 25S NMBR	PCT	BAS	FE CATE	TOTAL NMBR	PCT	GE 25S NMBR	PCT
67	8	38	FRT	49	1	2	1	5	HEI	49	7	15	5	24
2	1	5	409	99	3	6	3	14	631	99	1	2	0	0

ITCH LKF, RIN, TRUNK 4400, BASE MUNICH , NO. CALLS = 15, NO. GE 25S = 12

AL PCT	GE 25S NMBR	PCT	BAS	FE CATE	TOTAL NMBR	PCT	GE 25S NMBR	PCT	BAS	FE CATE	TOTAL NMBR	PCT	GE 25S NMBR	PCT
7	1	8	421	99	9	60	8	67	488	99	1	7	1	8

ITCH LKF, PRI, TRUNK 4500, BASE RAMSTIN, NO. CALLS = 1420, NO. GE 25S = 1056

AL PCT	GE 25S NMBR	PCT	BAS	FE CATE	TOTAL NMBR	PCT	GE 25S NMBR	PCT	BAS	FE CATE	TOTAL NMBR	PCT	GE 25S NMBR	PCT
0	2	0	ZAR	07	1	0	1	0	ALC	09	39	3	34	3
3	32	3	AVI	09	14	1	14	1	BEN	09	59	4	55	5
1	6	1	DIY	09	3	0	2	0	HAN	09	4	0	4	0
8	72	7	IRA	09	1	0	0	0	KAM	09	5	0	0	0
0	5	0	MLD	09	33	2	29	3	MOR	09	2	0	2	0
1	12	1	SPA	09	3	0	3	0	SVI	09	12	1	10	1
5	48	5	UHE	09	57	4	51	5	WEA	09	3	0	3	0
0	6	1	AIH	10	1	0	0	0	AUG	10	4	0	3	0
0	2	0	FRT	10	21	1	20	2	GIE	10	1	0	1	0
2	20	2	LEG	10	7	0	6	1	LON	10	1	0	1	0
2	18	2	NUR	10	7	0	5	0	ROT	10	2	0	0	0
0	4	0	WUR	10	3	0	3	0	WUR	10	3	0	2	0
0	0	0	HAN	41	3	0	1	0	IZM	41	1	0	1	0
0	1	0	AGN	49	2	0	1	0	BER	49	23	2	20	2
0	1	0	DUN	49	1	0	1	0	FRT	49	50	4	13	1
1	14	1	LUN	49	7	0	4	0	MLD	49	1	0	1	0
0	1	0	SEM	49	11	1	7	1	TOR	49	2	0	2	0
0	1	0	223	98	4	0	2	0	225	98	11	1	2	0
0	0	0	236	98	1	0	1	0	240	98	1	0	1	0
0	1	0	277	98	1	0	1	0	297	98	9	1	5	0
0	4	0	364	98	1	0	1	0	432	98	33	2	24	2
1	8	1	465	98	4	0	2	0	468	98	7	0	5	0
0	5	0	487	98	34	2	27	3	587	98	2	0	2	0
1	7	1	685	98	1	0	1	0	689	98	1	0	1	0
0	1	0	725	98	1	0	1	0	728	98	15	1	13	1
0	0	0	787	98	7	0	6	1	825	98	1	0	1	0

Figure 5-3. Base-to-Base Force Element Category Summary

2

BASE TO BASE-FORCE-ELEMENT-CODE SUMMARY FOR SWITCH LKF, PRI, TRUNK 4400, BASE MUNICH ·

BAS	FE CODE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CODE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CODE	TOTAL NMBR	TOTAL PCT
BER	4902	1	2	1	5	CTO	4902	32	67	8	38	FRT	4902	1	2
VAI	4905	1	2	1	5	487	99	1	2	1	5	489	99	3	6
633	99	1	2	1	5										

BASE TO BASE-FORCE-ELEMENT-CODE SUMMARY FOR SWITCH LKF, RIN, TRUNK 4400, BASE MUNICH ·

BAS	FE CODE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CODE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CODE	TOTAL NMBR	TOTAL PCT
CTO	4902	3	20	1	8	220	99	1	7	1	8	421	99	9	60
489	99	1	7	1	8										

BASE TO BASE-FORCE-ELEMENT-CODE SUMMARY FOR SWITCH LKF, PRI, TRUNK 4500, BASE RAMSTIN·

BAS	FE CODE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CODE	TOTAL NMBR	TOTAL PCT	GE 25S NMBR	GE 25S PCT	BAS	FE CODE	TOTAL NMBR	TOTAL PCT
ALC	0701	3	0	3	0	TOR	0701	6	0	2	0	ZAR	0701	1	0
ANK	0901	10	1	7	1	ATH	0901	37	3	32	3	AVI	0901	14	1
BIT	0901	11	1	11	1	CHI	0901	6	1	6	1	DIY	0901	3	0
HIW	0901	16	1	16	2	INC	0901	115	8	72	7	IRA	0901	1	0
LAK	0901	47	3	43	4	LIN	0901	6	0	5	0	MLD	0901	33	2
RHE	0901	2	0	2	0	SEM	0901	14	1	12	1	SPA	0901	3	0
TEM	0901	9	1	7	1	TOR	0901	74	5	48	5	UHE	0901	57	4
ZAR	0901	46	3	44	4	AUG	1001	4	0	3	0	BRE	1001	3	0
[illegible]	1001	8	1	6	1	KAI	1001	23	2	20	2	LEG	1001	7	0
MUN	1001	28	2	18	2	NUR	1001	7	0	5	0	SIU	1001	3	0
WOR	1001	3	0	3	0	WUR	1001	3	0	2	0	ZWE	1001	1	0
CAP	1003	2	0	2	0	GIE	1003	1	0	1	0	LON	1003	1	0
ATH	1008	1	0	0	0	BEN	4106	1	0	0	0	HAN	4106	3	0
IZM	4150	1	0	1	0	FEL	4701	1	0	1	0	LIN	4901	21	1
NAP	4901	6	0	0	0	RAM	4901	1	0	1	0	SEM	4901	11	1
BER	4902	23	2	20	2	DON	4902	1		1	0	FRT	4902	50	4
AGN	4903	2	0	1	0	LON	4903	7	0	4	0	NAP	4903	18	1
CAS	4904	1	0	1	0	VAI	4904	44	3	36	3	VAI	4905	10	1
223	98	4	0	2	0	225	98	11	1	2	0	227	98	39	3
236	98	1	0	1	0	240	98	1	0	1	0	271	98	5	0
277	98	1	0	1	0	297	98	9	1	5	0	347	98	5	0
364	98	1	0	1	0	432	98	33	2	24	2	440	98	8	1
465	98	4	0	2	0	468	98	7	0	5	0	471	98	1	0

1

SWITCH LKF, PRI, TRUNK 4400, BASE MUNICH , NO. CALLS = 48, NO. GE 25S = 21

TOTAL NMBR	PCT	GE 25S NMBR	PCT	BAS	FE CODE	TOTAL NMBR	PCT	GE 25S NMBR	PCT	BAS	FE CODE	TOTAL NMBR	PCT	GE 25S NMBR	PCT
32	67	8	38	FRT	4902	1	2	1	5	HEI	4902	7	15	5	24
1	2	1	5	489	99	3	6	3	14	631	99	1	2	0	0

SWITCH LKF, RIN, TRUNK 4400, BASE MUNICH , NO. CALLS = 15, NO. GE 25S = 12

TOTAL NMBR	PCT	GE 25S NMBR	PCT	BAS	FE CODE	TOTAL NMBR	PCT	GE 25S NMBR	PCT	BAS	FE CODE	TOTAL NMBR	PCT	GE 25S NMBR	PCT
1	7	1	8	421	99	9	60	8	67	488	99	1	7	1	8

SWITCH LKF, PRI, TRUNK 4500, BASE RAMSTIN, NO. CALLS = 1420, NO. GE 25S = 1056

TOTAL NMBR	PCT	GE 25S NMBR	PCT	BAS	FE CODE	TOTAL NMBR	PCT	GE 25S NMBR	PCT	BAS	FE CODE	TOTAL NMBR	PCT	GE 25S NMBR	PCT
6	0	2	0	ZAR	0701	1	0	1	0	ALC	0901	39	3	34	3
37	3	32	3	AVI	0901	14	1	14	1	BEN	0901	59	4	55	5
6	1	6	1	DIY	0901	3	0	2	0	HAN	0901	4	0	4	0
15	8	72	7	IKA	0901	1	0	0	0	KAM	0901	5	0	0	0
6	0	5	0	MLD	0901	33	2	29	3	MOR	0901	2	0	2	0
14	1	12	1	SPA	0901	3	0	3	0	SVI	0901	12	1	10	1
74	5	48	5	UHE	0901	57	4	51	5	WEA	0901	3	0	3	0
4	0	3	0	BKE	1001	3	0	2	0	FRT	1001	21	1	20	2
23	2	20	2	LEG	1001	7	0	6	1	MAN	1001	21	1	16	2
7	0	5	0	SIU	1001	3	0	3	0	VIC	1001	4	0	4	0
3	0	2	0	ZWE	1001	1	0	1	0	AGN	1003	6	0	6	1
1	0	1	0	LUN	1003	1	0	1	0	ROT	1003	2	0	0	0
1	0	0	0	HAN	4106	3	0	1	0	SPA	4106	2	0	2	0
1	0	1	0	LIN	4901	21	1	14	1	MLD	4901	1	0	1	0
1	0	1	0	SEM	4901	11	1	7	1	TOR	4901	2	0	2	0
1		1	0	FRT	4902	50	4	13	1	HEI	4902	6	0	4	0
7	0	4	0	NAP	4903	18	1	11	1	BRU	4904	2	0	2	0
34	3	36	3	VAI	4905	10	1	10	1	221	98	1	0	1	0
11	1	2	0	227	98	39	3	22	2	234	98	2	0	0	0
1	0	1	0	271	98	5	0	4	0	276	98	1	0	1	0
9	1	5	0	347	98	5	0	4	0	352	98	5	0	4	0
33	2	24	2	440	98	8	1	7	1	458	98	8	1	8	1
7	0	5	0	471	98	1	0	1	0	478	98	7	0	5	0

Figure 5-4. Base-to-Base Force Element Code Summary

2

5.1.4 Busy Hour Traffic

While the busy hour traffic volume may normally be calculated simply by taking the sum of the percentage occupancy of each trunk in the trunk group, this does not hold true for the European AUTOVON system using TDCS data. There are two reasons for this. The first is that the TDCS does not include the user's dial time in the holding time for originating calls, but does include dial time in the holding time for terminating calls. Therefore, the holding time for originating call dial time must be added to the TDCS holding time. A program was written to sum the holding times for originating calls, by trunk, by hour, adding a holding time figure for dial time based on the number of digits which were dialed. See Figure 5-5. The dial time for four-wire subscribers and operators averages about 750 ms per digit while dial time for other users averages about 2.2 seconds per digit. AUTOVON phone numbers have seven to twelve digits and, when all digits are dialed, the dial times average 5.25 or 9.2 seconds and 15.4 or 22 seconds, respectively (includes 200 ms for final matrix connection).

The abbreviations used in the column headings for Figure 5-5 and Figure 5-6 have the following meanings:

HR	Hour of day (Zulu time)
SUM HT	Sum of call holding times during that hour
SUM DD	Sum of dialing times for that hour
PCT	Percent trunk occupancy during that hour in that direction
NBR CALL	Number of calls in that direction during that hour
HTLT 25	Number of calls in that direction during that hour lasting less than 25 seconds
TG	Trunk Group number at AUTOVON Switch
NC	Number of calls originated on that trunk during that hour which terminated in the preceeding Trunk Group number

By modifying the program to sort the Call Data by terminating trunk, the terminating holding time per trunk, by hour was calculated. (See Figure 5-6.) By summing the originating and terminating occupancies thus determined for each trunk, then for each trunk group, then for each base, the individual base busy hour was determined. The data pertaining to the busy hour was then utilized to calculate offered traffic as described in Appendix D. It should be noted that treating all trunks to a particular base as if they were part of a single trunk group results in understating the offered traffic for those bases since a given percentage occupancy on a single group results in less congestion than the same percentage on two or more smaller groups. This has been done deliberately since actions are now being taken to extend

ONE-WAY TRUNK OCCU

HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25	TG	NC	TG	NC	T
08	2491	287	77	19	6	10	0	11	0	1
09	2010	421	67	28	9	10	0	11	0	1
10	1860	202	57	13	5	10	0	11	0	1
11	1785	178	54	12	6	10	0	11	0	1
12	1052	155	33	10	4	10	0	11	0	1
13	1814	218	56	14	5	10	0	11	0	1
14	2192	545	76	35	15	10	0	11	0	1
15	1634	530	61	34	18	10	0	11	0	1
16	1079	218	36	14	7	10	0	11	0	1

ONE-WAY TRUNK OCCU

HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25	TG	NC	TG	NC	T
08	1839	499	66	32	18	10	0	11	0	1
09	2460	374	78	24	10	10	0	11	0	1
10	1872	548	67	37	26	10	0	11	0	1
11	1412	365	49	24	12	10	0	11	0	1
12	553	109	18	7	3	10	0	11	0	1
13	2111	381	69	25	9	10	0	11	0	1
14	1934	421	65	27	13	10	0	11	0	1
15	1892	358	62	23	10	10	0	11	0	1
16	1215	233	40	15	7	10	0	11	0	1

ONE-WAY TRUNK OCCU

HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25	TG	NC	TG	NC	T
08	1076	406	41	29	17	10	0	11	0	1
09	203	125	9	13	7	10	0	11	0	1
10	2120	374	69	24	11	10	0	11	0	1

-WAY TRUNK OCCUPANCY FOR ORIGINATING TRUNK NUMBER 7100

NC	TG	NC	TG	NC	TG	NC	TG	NC	TG	NC
0	11	0	12	0	13	1	14	1	15	0
0	11	0	12	0	13	0	14	2	15	1
0	11	0	12	0	13	0	14	1	15	1
0	11	0	12	0	13	1	14	0	15	1
0	11	0	12	0	13	1	14	0	15	0
0	11	0	12	0	13	0	14	1	15	1
0	11	0	12	0	13	0	14	3	15	3
0	11	0	12	0	13	0	14	3	15	4
0	11	0	12	0	13	0	14	1	15	0

-WAY TRUNK OCCUPANCY FOR ORIGINATING TRUNK NUMBER 7101

NC	TG	NC	TG	NC	TG	NC	TG	NC	TG	NC
0	11	0	12	0	13	0	14	6	15	1
0	11	0	12	0	13	0	14	2	15	1
0	11	0	12	0	13	4	14	2	15	2
0	11	0	12	0	13	1	14	0	15	1
0	11	0	12	0	13	0	14	1	15	2
0	11	0	12	0	13	1	14	1	15	2
0	11	0	12	0	13	0	14	1	15	2
0	11	0	12	0	13	1	14	2	15	1
0	11	0	12	0	13	0	14	2	15	0

-WAY TRUNK OCCUPANCY FOR ORIGINATING TRUNK NUMBER 7102

NC	TG	NC	TG	NC	TG	NC	TG	NC	TG	NC
0	11	0	12	0	13	2	14	3	15	6
0	11	0	12	0	13	1	14	0	15	3
0	11	0	12	0	13	0	14	0	15	2

Figure 5-5. Originating Trunk Occupancy

ONE-WAY TRUNK OCCUPANCY FOR

HR	SUM HT	SUM DD	PCT	NBR CALL	HT_T 25	HR	SUM HT	SUM DD	PC
08	1030	0	28	4	0	09	1603	0	4
11	555	0	15	3	0	12	327	0	
14	386	0	10	2	0	15	102	0	

ONE-WAY TRUNK OCCUPANCY FOR

HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25	HR	SUM HT	SUM DD	PC
08	753	0	20	3	0	09	381	0	1
11	757	0	21	2	0	12	243	0	
14	676	0	18	4	0	15	333	0	

ONE-WAY TRUNK OCCUPANCY FOR

HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25	HR	SUM HT	SUM DD	PC
08	106	0	2	1	0	09	45	0	
14	352	0	9	1	0	15	31	0	

ONE-WAY TRUNK OCCUPANCY FOR

HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25	HR	SUM HT	SUM DD	PC
09	291	0	5	2	0	10	629	0	1
13	380	0	10	6	4	14	45	0	
16	359	0	9	7	3				

ONE-WAY TRUNK OCCUPANCY FOR

HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25	HR	SUM HT	SUM DD	PC
09	2	0	0	1	1	13	16	0	

NCY FOR TERMINATING TRUNK NUMBER 6900 PAGE 4

SUM DD	PCT	NBR CALL	HTLT 25	HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25
0	44	8	2	10	1031	0	28	8	2
0	9	1	0	13	1358	0	37	3	0
0	2	1	0	16	817	0	22	7	4

NCY FOR TERMINATING TRUNK NUMBER 7000

SUM DD	PCT	NBR CALL	HTLT 25	HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25
0	10	7	3	10	1260	0	34	12	3
0	6	1	0	13	899	0	24	8	2
0	9	3	1	16	858	0	23	9	4

NCY FOR TERMINATING TRUNK NUMBER 7001

SUM DD	PCT	NBR CALL	HTLT 25	HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25
0	1	1	0	13	48	0	1	1	0
0	0	1	0	16	49	0	1	1	0

NCY FOR TERMINATING TRUNK NUMBER 7100

SUM DD	PCT	NBR CALL	HTLT 25	HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25
0	17	7	4	11	50	0	1	1	0
0	1	1	0	15	103	0	2	2	1

NCY FOR TERMINATING TRUNK NUMBER 7101

SUM DD	PCT	NBR CALL	HTLT 25	HR	SUM HT	SUM DD	PCT	NBR CALL	HTLT 25
0	0	1	1						

Figure 5-6. Terminating Trunk Occupancy

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operator trunks to "dial 8" users and to dual-home PBXs that have been split-homed. As these are accomplished, the average occupancy should be reduced as the grade of service is improved, offsetting the understatement offered in this report.

5.1.5 USAF AUTOVON Matrices

5.1.5.1 USAF Base-to-Base AUTOVON Matrix

Having determined the busy-hour total traffic offered to AUTOVON by each base and having determined the calling pattern separately, it now remains to properly merge the two results to produce a base-to-base traffic model. Since the DCA has indicated that one of the potential uses of this model is to employ the results for network configuration studies, it would be inappropriate to provide an hour-by-hour model that would impose configuration requirements on the network that change hourly. Further, in view of the fact that total carried traffic is essentially constant throughout the workday (except during the lunch hour), regardless of the hourly pattern changes, it seems reasonable to develop a "pseudo-busy hour" model which allocates total busy hour traffic offerings to individual destinations based upon the percentage of the total traffic that destination receives. That is, if a particular base originates 10 Erlangs of traffic during the busy hour and 300 Erlangs during the week, of which 30 go to each of 10 destinations, then our matrix would say that 1 Erlang of traffic goes to each of those destinations during the busy hour. While this might appear to understate the need for CONUS trunking, Europe-wide policy allowing personnel to place and receive CONUS calls in their offices and quarters after normal working hours off-loads a substantial portion of CONUS traffic from office overlap hours.

The final USAF busy hour AUTOVON matrix is presented in Figure 5-7. The y-axis represents USAF bases originating calls and the x-axis is USAF bases in Europe receiving those calls. Table 5-1 lists the abbreviations used. The numbers at the intersection of two bases gives the busy-hour AUTOVON traffic from the originating base to the called location, in Erlangs. The rightmost twelve columns give the traffic in Erlangs: to CONUS, to non-USAF subscribers and users homed to each of the ten European AUTOVON switches and to total busy hour offered load. The lack of traffic from USAF bases in Greece and Turkey is due to the fact that the TDCS at Mt. Pateras has not yet become operational. When it does, those bases should be added to this matrix using the same process.

5.1.5.2 USAF Base-to-Force Element AUTOVON Matrix

Using essentially the same process previously defined for the base-to-base AUTOVON matrix, but substituting the force element categories of the calls' destinations for the base identification, the Base-to-Force Element matrix shown in Figure 5-8 was developed. The codes used in the matrix are explained in Table 5-2.

Table 5-1
Table of Abbreviations for Figure 5-7

ABBR	Location	ABBR	Location
ALC	Alconbury	MID	Mildenhall
ANK	Ankara	MOR	Moron
ATH	Athens	MTF	Mt. Franca
AVI	Aviano	MTL	Mt. Limbari
BEN	Bentwaters	MTP	Mt. Pateras
BIT	Bitburg	MTR	Mt. Reggio
CHI	Chicksands	MTV	Mt. Vergine
CRO	Croughton	MUE	Muhl
CTO	Coltano	RAM	Ramstein
DIY	Diyarbakir	RHE	Rhein Main
DON	Donnersberg	ROM	Rome
FEL	Feldberg	SCH	Schoenfeld
FYL	Fylingdales	SCL	Sculthorpe
HAN	Hahn	SCO	Scott
HIN	Hillingdon	SEM	Sembach
HIW	High Wycombe	SOS	Soesterberg
HUM	Humosa	SPG	Spangdahlem
INC	Incirlik	SVI	San Vito
IRA	Iraklion	TEM	Tempelhof
IZM	Izmir	TOR	Torrejon
KAM	Karamursel	UHE	Upper Heyford
LAK	Lakenheath	WEA	Weathersfield
LIN	Lindsey	WEI	Weisbaden
LKF	Langerkopf	WOO	Woodbridge
MAM	Martlesham Heath	ZAR	Zaragoza
MCG	McGuire	ZWE	Zweibrucken

	ALC	ANK	ATH	AVI	BEN	BIT	CHI	CRO	DIY	FEL	FYL	HAN	HIN	HW	HUM	INC	IRA	IZM	KAM	LAK	LIN	LKF	MAM	MCG	MID	MOR	MTF	MTL	MTP	MTR	MTV	MUE
ALCONBURY	.01		.01	.01	.41	.08	.41	.20		.01		.06	.03	.30	.01	.01				.97	.16	.01	.03	.10	.85				.09			
AVIANO	.02		.06		.03	.03	.01	.01		.01		.03		.02	.01	.10				.03	.08	.01	.01	.02	.07		.03	.08		.06	.21	
BENTWATERS	.32		.01	.03	.01	.17	.11	.11				.15	.01	.11					.01	1.16	.11	.01	.06		1.01			.01				
BITBURG	.02	.01		.01	.01							.18				.02			.04	.04	.13				.01							
CHICKSANDS								.33					.33									.66	.33									
CROUGHTON	.06		.02	.01	.12	.01	.03	.04		.01		.01	.08	.16		.05				.05	.04		.09	.08	.22				.02		.02	
FELDBERG				.09		.03		.01		.03		.03	.07		.02						.02	.30	.03					.01			.09	
FYLINGDALES	.01																						.01									
HAHN	.09	.01	.05	.04	.15	.52	.04	.02		.02		.03		.01	.01	.06			.02	.17	.08	.01			.03							
HILLINGDON					.01		.02	.15		.01			.01	.03	.01							.04	.01						.01		.01	
HIGH WYCOMBE	.16		.03		.28	.03	.09	.53		.01		.02	.03	.09		.01			.01	.36	.01				.28							
HUMOSA													.03		.10								.01								.01	
KAPAUN BARRACKS	.05		.01					.04								.01									.04							
LAKENHEATH	.56		.01	.03	1.04	.04	.21	.05				.10	.01	.26		.07			.01	.02	.28	.03	.01	.01	.05							
LINDSEY																																
LANGERKOPF				.10		.03				.33		.01	.06	.02	.07						.02	.94	.07						.01		.03	.10
McGUIRE		.02	.07	.04				.03		.27		.01			.01	.16									.18							
MILDENHALL	.36		.05	.07	.87	.05	.09	.24				.07	.06	.22	.05	.16				.03	.10	.05	.02	.07	.06	.01			.02			
MORON		.02	.02	.04											.01						.02											
MT. FRANCA				.13																	.01										.01	
MT. LIMBARI				.25						.01									.01		.01									.01	.01	
MT. REGGIO				.22																											.07	
MT. VERGINE		.01		.44		.03		.01		.02			.03		.02				.01		.03	.01	.01				.01		.02	.03	.24	
MUHL				.02						.01			.01	.01							.01	.01	.03									
PRUEM						.07						.02									.01											
RAMSTEIN	.34	.19	.08	.45	.73	.18	.03	.08	.01	.09	.02	.24	.02	.10	.01	.74	.04		.09	.60	.30	.22	.05	.14	.65	.01					.02	.04
RHEIN MAIN	.02	.02	.09	.08	.07	.27		.07	.01	.06		.14	.01	.02	.04	.42	.02		.02	.05	.11	.05		.15	.25			.01				.02
ROME			.01	.14											.02						.03			.01	.01						.01	
SCHOENFELD	.01			.01		.30				.01		.15						.03			.05	.05										
SCULTHORPE	.02				.02															.74					.14							
SCOTT										.03		.04				.01									.05							
SEMBACH	.03	.01	.01	.01	.07	.11	.01	.03		.02		.10	.01	.01		.01				.03	.15	.37	.01		.05						.05	.01
SOSTRBRGN						.01		.01				.09																				
SPANGDAHLEM	.06			.02	.17	.85						.88				.01			.01	.18					.06	.01						.01
SANVITO			.04	.14		.03	.02					.02					.06		.02	.01	.13	.04	.01					.01	.01	.02	.03	
TEMPELHOF										.01												.09										
THULE		.01																														
TORREJON			.53	.81	.08	.08	.03	.11	.06			.08		.03	.03	1.09	.11			.22	.45	.06		.22	.25	.08		.08				
UPPER HEYFORD	.20		.01	.03	.29	.01	.07					.01	.01	.40						.48	.08				.46							
WEATHERSFIELD	.98				.16		.10	.12				.01	.01	.06						.20		.01	.02		.16							
WOODBRIDGE	.01					.01		.01												.01					.10							
ZARAGOZA	.45		.02	.06	.06	.11						.72		.01		.03	[illegible]			.02	.20	.01		.02	.21	.06						
ZWEIBRUCKEN	.10		.01		.08	.09	.04	.02		.01		.11	.01						.01	.06	.03	.03			.04							

TL	MTP	MTR	MTV	MUE	RAM	RHE	ROM	SCH	SCL	SCO	SEM	SOS	SPG	SVI	TEM	TOR	UHE	WEA	WEI	WOO	ZAR	ZWE	CONUS	CTO	DON	FEL	HIN	HUM	LKF	MAM	MTP	MTV	SCH	TOTAL
	.08				1.16	.16		.01	.03		.10	.01	.04			.07	.48	.35	.13		.21	.14		.01	.56	.06	.15		.15	.02				7.80
[illegible]		.06	.21		1.12	.18	.01				.02		.03	.08		.51	.03		.10		.13	.02		.14	.15	.07	.03	.02	.03	.01		.06		3.67
[illegible]					1.77	.43			.01		.27		.16			.11	.27	.08	.20		.18	.10		.01	.54	.10	.05	.01	.01	.14		.08		7.92
					.35	.16		.03	.01		.10		.04	.02	.02	.02	.07		.10		.03	.05	.10	.05	.49	.27			.08					2.46
					.33																					.99	.33		.99	.33		.33		4.95
	.02		.02		.33	.11			.02		.02					.02	.02	.06	.02				.50	.02	.47	.11	.07	.08		.06	.01	.05		3.09
[illegible]			.09		.26	.43		.08			.05				.01				.01				.50	.03	.58	.45			.15					3.28
																							.11							.02				0.15
					.38	.34		.15	.02		.19	.05	.86	.01		.25	.03		.44		1.11	.19			1.38	.48	.01	.01	.13	.08		.01		7.48
	.01		.01			.02		.03									.03		.01				.05					.03						0.48
					.41	.16			.01		.02					.01	1.49	.09	.01					.01	.72	.09	.23	.01		.06				5.26
			.01													.01								.03	.04			.07						0.30
					.01	.05										.03	.02				.01		.01		.02									0.30
					1.77	.29		.01	.30		.02		.17		.28	.07	1.13	.17	.22			.05		.02	.41	.19	.23		.02	.04		.01		8.19
	.01		.03	.10	1.50	1.06		.13			.19								.12			.07	.02		3.02	.13			.62					8.65
					.86	.56	.01									.27									.01			.20		.01		.01		2.72
	.02				1.45	.73		.02	.05		.09		.04	.01		.14	.71	.11	.08	.01	.22	.05	2.05		.12	.14	.21	.01	.04	.05		.01		6.98
					.03											.94	.02		.03		.17	.07		.09	.03			.44				.02		1.95
			.01																				.01		.01							.01		0.18
		.01	.01		.01									.04									.01											0.36
			.07											.10																		.12		0.51
	.02	.03	.24											.09		.03							.07		.07	.01		.03	.01			.13		1.36
					.03	.12					.01								.03						.01									0.30
						.06					.27		.03						.01							.01			.01					0.40
			.02	.04	.28	.56		.05	.01		.73		.27	.19	.08	1.41	.66	.04	.19		.67	.25	1.29	.09	3.18	1.10	.11	.10	.33	.05	.01	.15		17.42
.01				.02	.26	.01		.04			.17		.15	.03	.03	.26	.05		.11		.06	.05	.44	.05	1.08	.40	.07	.12	.21	.04		.07		5.65
			.01		.08	.02								.05					.01					.07	.09	.02	.02		.06			.23		0.88
					.07	.18		.01								.03		.03	.06						.15					.01				1.15
					.08				.02									.08							.10		.06			.02				1.20
					.05	.15																			.03	.08								0.44
			.05	.01	.45	.23		.04			.01	.02	.13		.03	.07	.06		.19		.38	.10	.11	.01	1.86	.43	.03	.02	.13			.03		5.43
					.20								.01						.01			.04		.01	.01				.10					0.40
				.01	1.24	.65	.04	.18			.16		.13	.01		.10			.55		.65	.41	.18		1.90	.75	.24		.14			.03		9.62
.01	.01	.02	.03		.07	.04					.01				.03	.01			.14				.19	.10	.14	.04			.05			.19		1.00
																									.31	.01								0.42
																							.03											0.04
[illegible]					3.00	.92	.06				.17		.20	.03		.06	.22		.20		.87	.08	1.96	.34	.90	.28	.06	.64	.03	.03	.03	.17		14.86
					1.31	.13			.01		.13		.03	.03		.05	.07	.01	.13		.01	.03			.45	.02	.10					.02		4.58
					.12				.02		.03				.01	.01	.06						1.49		.30	.05	.22			.04				4.18
					.02	.01																	.69							.07				0.93
					.92	.12			.03		.14	.10	.41			.61			.17			.09	.01	.98	.09	.03		.17	.02	.07		.02		5.20
					.63	.19	.01				.07		.11		.03	.09	.02		.07		.06	.02			.94	.18	.04		.09	.02				3.21

Figure 5-7. USAF Base-to-Base Busy Hour AUTOVON Traffic Matrix (In Erlangs)

Table 5-2
Codes Used in Figure 5-8

01	Command
02	Operations
03	Maintenance
04	Resources Management
05	Combat Support Group
06	Medical
07	Communications
08	Weather
09	Operators, USAF
10	Tenants, USA and USN Operators
98	CONUS
99	Not in Directory (Direct Dialled to USAF)

5.1.5.3 USAF Base-to-Base-by-Force Element AUTOVON Matrix

The most detailed AUTOVON matrix to be presented, Figure C-1 provides a combination breakout of busy hour traffic from each originating location to each USAF destination (and others) by force-element category. This matrix differs from all others in this report in that the matrix values are in percentages of total offerred traffic rather than in Erlangs, to facilitate updating. Because of its size, it is included in Appendix C rather than in this Section.

5.2 Non-AUTOVON

The USAF in Europe utilizes its VF Dial System, the Army's DDD, ringdown trunks, foreign exchange lines and tie lines to supplement the AUTOVON system for common-user voice traffic. Many portions of these systems directly parallel the AUTOVON System and calls blocked in one system may be immediately attempted in another. The discussion presented in Appendix D regarding AUTOVON congestion and the determination of offered versus carried traffic apply to the VF Dial and DDD systems as well. However, due to the fact that traffic is frequently offered to more than one system (crosses over in an attempt to find an available path), determining the total offered traffic to each system would seriously overstate the total offered traffic to the combined common-user systems. Estimation of the crossover cannot easily be determined, being a complex function of user behavior. It was decided to assume that the difference between carried traffic and offered traffic in these non-AUTOVON systems is approximately equal to the crossover traffic. Thus, summing the AUTOVON offered load and the carried non-AUTOVON loads yields the total common-user offered traffic.

Since calling patterns for non-AUTOVON systems were not generally available from the NCA studies, and since the non-AUTOVON carried traffic roughly

	01	02	03	04	05	06	07	08	09	10	98	99
Alconbury	8.6	2.2	3.0	4.0	7.0	2.6	0.9	0.2	28.5	12.0	0.3	30.7
Aviano	4.4	4.2	6.9	3.6	2.8	1.3	10.3	0.2	18.2	11.7	0.7	36.0
Bentwaters	10.2	1.2	2.4	9.8	5.6	2.4	2.2	0.1	31.7	9.2	0.3	25.0
Bitburg	6.5	1.7	2.4	2.7	7.4	2.4	4.1	-	24.1	32.7	4.4	11.7
Chicksands	-	-	-	-	-	-	15.4	-	7.7	7.7	13.1	56.2
Croughton	0.7	0.8	0.2	0.2	0.2	-	10.0	0.7	29.3	15.9	18.4	23.8
Feldberg	-	0.2	-	0.8	3.3	0.2	24.2	-	7.5	22.4	14.8	26.6
Fylingdales	-	-	-	-	-	-	4.8	-	4.8	14.3	76.2	-
Hahn	3.0	5.8	6.8	6.9	3.7	1.2	2.6	1.5	14.8	21.6	19.5	12.7
Hillingdon	-	-	3.0	2.0	1.0	-	23.0	-	10.0	9.0	8.0	44.0
High Wycombe	4.8	0.8	0.2	7.0	12.4	1.0	1.9	23.6	17.6	-	-	30.8
Humosa	-	-	-	-	-	-	33.3	-	5.6	5.6	-	55.5
Kapaun Bks	2.3	-	-	-	-	-	-	58.1	16.3	-	2.3	20.9
Langerkopf	.3	.3	.8	.5	3.3	.8	22.9	-	5.1	14.9	.3	51.02
McGuire	1.5	.7	-	14.0	-	-	4.4	-	38.3	18.7	-	22.4
Mildenhall	7.9	2.5	2.5	4.6	9.4	.1	3.45	.2	18.8	9.9	23.14	17.53
Moron	3.0	-	2.0	11.5	14.9	-	3.4	-	13.3	14.7	-	37.1
Mt. Franca	-	-	-	-	-	-	12.0	-	68.0	4.0	-	16.0
Mt. Limbari	-	-	-	3.9	13.5	-	12.6	-	44.2	2.9	1.9	21.1
Mt. Reggio	-	-	-	2.6	5.2	-	10.4	-	45.5	27.3	-	9.1
Mt. Vergine	-	-	-	.5	-	-	36.1	-	35.1	1.6	5.2	21.5
Muehlzch	-	-	-	5.0	-	-	50.0	-	12.5	2.5	-	30.0
Pruem	9.9	-	-	1.4	7.0	-	-	-	8.5	15.5	-	57.8
Ramstein	2.8	2.9	3.8	6.8	5.7	.8	2.5	.2	20.7	19.4	8.1	26.4
Rhein Main	1.6	1.9	1.9	2.5	2.9	.8	4.7	1.4	19.5	23.9	10.2	28.7
Rome	1.8	-	-	-	1.8	-	3.5	-	54.4	5.3	1.8	31.6
Schoenfeld	-	-	-	1.7	2.3	1.1	37.1	-	15.4	9.7	4.0	28.6
Sculthorpe	5.3		5.3	13.3	8.0	12.0	2.7	-	18.7	4.0	-	30.7
Scott	1.7	6.7	-	3.3	5.0	-	1.7	-	41.3	3.3	-	37.0
Sembach	3.5	3.5	4.2	3.0	2.8	.9	3.2	.5	12.0	35.7	2.3	28.5
Soesterberg	11.3	5.6	-	5.6	-	2.8	12.7	-	14.1	26.8	-	21.1
Spangdahlem	4.3	3.8	4.8	4.4	4.3	2.2	1.5	.1	18.6	35.4	1.8	18.8
San Vito	1.0	1.6	1.3	.3	1.0	6.4	3.2	-	27.8	21.1	11.8	24.6
Tempelhof	4.6	12.6	-	13.9	-	-	6.0	-	8.6	23.8	-	30.5
Thule	-	-	-	-	-	-	-	-	33.3	-	66.7	-
Torrejon	6.0	3.1	1.1	.9	7.3	.9	2.9	.2	42.1	1.8	16.9	17.1
U. Heyford	18.2	1.8	1.1	6.6	5.7	3.1	1.6	.4	29.8	5.9	.1	25.1
Weathersfield	.2	-	-	-	.2	-	.7	-	44.1	4.5	5.3	45.1
Wiesbaden	6.8	4.3	-	-	1.9	-	2.5	-	21.6	11.7	42.6	8.7
Woodbridge	.2	-	.2	3.2	-	-	.8	-	7.1	3.2	80.1	5.3
Zaragoza	6.4	2.5	11.5	5.3	4.3	3.5	2.0	.2	35.3	5.7	.6	22.8
Zweibrucken	6.4	2.6	3.5	7.8	4.0	1.7	1.7	.3	16.8	32.2	-	22.9

Figure 5-8. USAF Base-to- Force Element Traffic Matrix (In Percent)

equals the AUTOVON offered traffic, detailed generic force element breakdowns of all offered traffic cannot be derived in a meaningful form. However, base-to-base models may be easily developed and generic models are possible to derive at the wing level since a USAF base generally represents a single functional wing element.

5.2.1 USAF Base-to-Base Matrix

Figure 5-9 presents the total USAF common user traffic needlines derived by joining the non-AUTOVON traffic with the AUTOVON offerings. It must be recognized that the performance of each of the systems included will have an effect on the performance of the others as users attempt to place their calls through the available system that offers the greatest change of success (or perceived chance, which is not necessarily the same). Low precedence users, however, may continue to attempt calls through VF Dial and DDD in the afternoon even though they might obtain better service to a particular destination through AUTOVON simply because they know their call will last 5-10 minutes and do not wish to be preempted after achieving a connection. Considerations such as these, and those discussed in Section 9, will effect the use of this model in supporting potential network improvements.

5.2.2 USAF Generic Matrix

As previously discussed, nearly all USAF bases in Europe are single-mission bases, supporting a single wing or group. The exceptions to this are the four bases at Ramstein, Mildenhall, Sembach and Torrejon, each of which supports a Headquarters Command (USAFE, 3rd A.F., 16th A.F., 17th A.F.). Due to differences in host nation agreements, inter-service support agreements, etc., common user voice traffic generated by similar units in different nations exhibit different patterns. Since, with the exception of Tactical Fighter Wings, there are no two bases located in the same geographic area performing the same mission, the generic model is generally in the form of a base-to-base model. However, should additional bases be established (or existing ones moved), this matrix will provide an excellent initial step in determining the common user voice needlines. Figure 5-10 presents the final USAF Generic Common-User Voice System Matrix.

5.2.3 USAF Alternate Volume Estimation Method

In conducting analyses of relationships between various parameters, it was discovered that there is an excellent correlation between the number of Class "A" phone lines on a given base and the total busy hour traffic generated by that base. The figure does, naturally vary somewhat as a function of the primary mission element on the base and the country in which it is located. The basic figure which may be used to obtain a rough first estimation is 1.7 CCS per Class "A" phone line. As a closer approximation, the adjustment factors given in Table 5-3 may be added to or subtracted from the basic figure. Since Headquarters Commands do not exist (presently) at independent bases, their correction factors must be joined with those of the other primary mission element on that base.

	ALC	ANK	ATH	AVI	BEN	BIT	CHI	CRO	DIY	FEL	FYL	HAN	HIN	HIW	HUM	INC	IRA	IZM	KAM	LAK	LIN	LKF	MAM	MCG	MID	MOR	MTF	MTL	MTP	MTR	MTV	M
ALCONBURY	.01		.01	.01	.41	.08	.41	.20		.01		.06	.03	.30	.01	.01				1.23	.16	.01	.03	.10	.85				.09			
AVIANO	.02		.06		.03	.03	.01	.01		.01		.03		.02	.01	.10				.03	.08	.01	.01	.02	.07		.03	.08		.06	.21	
BENTWATERS	.32		.01	.03	.01	.17	.11	.11				.15	.01	.11					.01	1.16	.11	.01	.31		1.01			.01				
BITBURG	02	.01		.01	.01							.37				.02			.04	.04	.13				.01							
CHICKSANDS								.33					.33									.66	.33									
CHOUGHTON	.06		.02	.01	.12	.01	.03	.04		.01		.01	.08	.16		.05				.05	.04		.09	.08	.22				.02		.02	
FELDBERG				.09		.03		.01		.03		.03	.07		.02						.02	.30	.03					.01			.09	
FYLINGDALES	.01																						.01									
HAHN	.09	.01	.05	.04	.15	.74	.04	.02		.02		.03		.01	.01	.06			.02	.17	.08	.01			.03							
HILLINGDON					.01		.02	.15		.01			.01	.03	.01							.04	.01						.01		.01	
HIGH WYCOMBE	.16		.03		.28	.03	.09	.53		.01		.02	.03	.09		.01			.01	.36	.01				.28							
HUMOSA													.03		.10								.01								.01	
KAPAUN BARRACKS	.05		.01					.04								.01									.04							
LAKENHEATH	.56		.01	.03	1.04	.04	.21	.05				.10	.01	.26		.07			.01	.02	.28	.03	.01	.01	4.02							
LINDSEY																																
LANGERKOPF				.10		.03				.33		.01	.06	.02	.07						.02	.94	.07						.01		.03	[illegible]
MCGUIRE		.02	.07	.04				.03		.27		.01			.01	.16									.18							
MILDENHALL	.54		.05	.07	1.15	.05	.09	.24				.07	.06	.22	.05	.16				4.42	.10	.05	.02	.07	.06	.01			.02			
MORON		.02	.02	.04											.01						.02											
MT. FRANCA				.13																	.01										.01	
MT. LIMBARI				.25						.01									.01		.01									.01	.01	
MT. REGGIO				.22																											.07	
MT. VERGINE		.01		.44		.03		.01		.02			.03		.02				.01		.03	.01	.01				.01		.02	.03	.24	
MUHL				.02						.01			.01	.01							.01	.01	.03									
PRUEM						.07						.02									.01											
RAMSTEIN	.34	.19	.60	.45	.73	1.93	.03	.08	.01	.09	.02	2.27	.02	.10	.01	.74	.04		.09	.60	.30	.22	.05	.14	.65	.01					.02	[illegible]
RHEIN MAIN	.02	.02	.09	.08	.07	.27		.07	.01	.06		.14	.01	.02	.04	.42	.02		.02	.05	.11	.05		.15	.25			.01				[illegible]
ROME			.01	.14											.02						.03			.01	.01						.01	
SCHOENFELD	.01			.01		.30				.01		.15						.03			.05	.05										
SCULTHORPE	.02				.02															.74					.14							
SCOTT										.03		.04				.01									.05							
SEMBACH	.03	.01	.01	.01	.07	.11	.01	.03		.02		.10	.01	.01		.01				.03	.15	.37	.01		.05						.05	[illegible]
SOSTHBRGN						.01		.01				.09																				
SPANGDAHLEM	.06			.02	.17	3.74						.88				.01			.01	.18					.06	.01						[illegible]
SANVITO			.04	.14		.03	.02					.02					.06		.02	.01	.13	.04	.01					.01	.01	.02	.03	
TEMPELHOF										.01												.09										
THULE		.01																														
TORREJON			.53	.81	.08	.08	.03	.11	.06			.08		.03	.03	1.09	.11			.22	.45	.06		.22	.25	.08		.08				
UPPER HEYFORD	.20		.01	.03	.29	.01	.07	.89				.01	.01	.40						.48	.08				.63							
WEATHERSFIELD	1.44				.41		.38	.34				.01	.01	.25						.46		.01	.02		.30							
WOODBRIDGE	01				1.06	.01		.01												.01					.10							
ZARAGOZA	45		.02	.06	.06	.11						.72		.01		.08	[illegible]			.02	.20	.01		.02	.21	.06						
ZWEIBRUCKEN	10		.01		.08	.09	.04	.02		.01		.11	.01						.01	.06	.03	.03			.04							

TP	MTR	MTV	MUE	RAM	RHE	ROM	SCH	SCL	SCO	SEM	SOS	SPG	SVI	TEM	TOR	UHE	WEA	WEI	WOO	ZAR	ZWE	CONUS	CTO	DON	FEL	HIN	HUM	LKF	MAM	MTP	MTV	other	TOTAL
.08				1.16	.16		.01	.03		.10	.01	.04			.07	.48	.70	.13		.21	.14		.01	.56	.06	.15		.15	.02			.36	8.57
	.06	.21		1.12	.18	.01				.02		.03	.08		.51	.03		.10		.13	.02	.25	.14	.15	.07	.03	.02	.03	.01		.06		3.92
				1.77	.43			.01		.27		.16			.11	.27	.37	.20	.42	.18	.10	.25	.01	.54	.10	.05	.01	.01	.14		.08	13.96	23.09
				3.68	.16		.03	.01		.39		3.31	.02	.02	.02	.07		.10		.03	.05	.15	.05	.49	.27			.08				1.71	11.30
				.33													.14								.99	.33		.99	.33		.33	.25	5.34
.02		.02		.47	.11			.02		.02					.02	2.15	.06	.02				.50	.02	.47	.11	.07	.08		.06	.01	.05	.90	6.26
		.09		.26	.43		.08			.05				.01				.01				.50	.03	.58	.45			.15					3.28
																						.11							.02				0.15
				4.94	.34		.15	.02		.51	.48	.86	.01		.25	.03		.44		1.11	.19	.05		1.38	.48	.01	.01	.13	.08		.01	2.63	15.69
.01		.01			.02		.03									.03		.01				.05					.03						0.48
				.41	.16			.01		.02					.01	1.85	.23	.01				.25	.01	.72	.09	.23	.01		.06			2.50	8.51
		.01													.01								.03	.04			.07						0.30
				.01	.05										.03	.02				.01		.01		.02									0.30
				1.77	.29		.01	.61		.02		.17		.28	.07	1.13	.28	.22			.05	.25	.02	.41	.19	.23		.02	.04		.01	.32	13.15
.01		.03	.10	1.50	1.06		.13			.19								.12			.07	.02		3.02	.13			.62					8.65
				.86	.56	.01									.27									.01			.20		.01		.01		2.72
.02				1.83	.90		.02	.05		.09		.04	.01		.36	.89	.43	.08	.01	.22	.05	2.05		.12	.14	.21	.01	.04	.05		.01	1.24	16.35
				.03											.94	.02		.03		.17	.07		.09	.03			.44				.02		1.95
		.01																				.01		.01							.01		0.18
	.01	.01		.01									.04									.01											0.36
		.07											.10																		.12		0.51
.02	.03	.24											.09		.03							.07		.07	.01		.03	.01			.13		1.36
				.03	.12					.01								.03						.01									0.30
					.06					.27		.03						.01							.01			.01					0.49
		.02	.04	.28	2.66		.05	.01		5.37		1.69	.19	.08	1.41	.66	.04	6.19		.67	1.58	3.83	.09	8.57	1.10	.11	.10	.33	.05	.01	.15		44.62
			.02	2.48	.01		.04			.17		.15	.03	.03	.26	.05		2.88		.06	.05	.44	.05	1.08	.40	.07	.12	.21	.04		.07	3.17	13.79
		.01		.08	.02								.05					.01					.07	.09	.02	.02		.06			.23		0.88
				.07	.18		.01								.03		.03	.06						.15					.01				1.15
				.08				.02									.08							.10		.06			.02				1.28
				.05	.15																			.03	.08								0.44
		.05	.01	5.56	.23		.04			.01	.02	.13		.03	.07	.06		.19		.38	.10	.22	.01	1.86	.43	.03	.02	.13			.03		10.65
				.20								.01						.01			.04	.18	.01	.01				.10					0.40
			.01	2.89	.65	.04	.18			.45		.13	.01		.10			.55		.65	.41	.18		1.90	.75	.24		.14			.03	.65	15.10
.01	.02	.03		.07	.04					.01				.03	.01			.14				.19	.10	.14	.04			.05			.19		1.60
																								.31	.01								0.42
																						.03											0.04
				3.00	.92	.06				.17		.20	.03		.06	.22		.20		.87	.08	1.96	.34	.90	.28	.06	.64	.03	.03	.03	.17		14.06
				1.31	.13			.01		.13		.03	.03		.05	.07	.15	.13		.01	.03	.25		.45	.02	.10					.02	1.26	7.29
				.12				.02		.03				.01	.01	.24						.25		.30	.05	.22			.04			.94	5.06
				.02	.01																	.69							.07				1.90
				.92	.12			.03		.14	.10	.41			.61			.17			.09	.01	.08	.09	.03		.17	.02	.07		.02		5.29
				.63	.19	.01				.07		.11		.03	.09	.02		.07		.06	.02			.94	.18	.04		.09	.02				3.21

Figure 5-9. USAF Total Busy Hour Base-to-Base Traffic Matrix (In Erlangs)

2

FORCE ELEMENT	AREA	USAFE	NUMBERED AF (3)		TAC FIGHTER WING (8)		TAC RECON WING (2)		TAC AIRLIFT WING (2)		TAC TRNG. WING (1)		TAC GROUP (2)		OTHER AIR FORCE TOTAL		OTHER SERVICES TOTAL		CONUS
			SAME	OTHER	SAME	OTHER	SAME	OTHER	SAME	OTHER	SAME	OTHER	SAME	OTHER	SAME	OTHER	SAME	OTHER	
USAFE	FRG		4.94	.75	.31	.46	1.36	.28	2.28	.10		.07	.43	.43	6.24	2.11	6.46	.37	3.84
NUMBERED AF	G.B.	1.32		-	1.68	-	.49	.03		.85		.17		-	.26	-	1.47	-	1.58
	FRG	1.25		-	1.60	-	.08	.03	.10	.05		.25		-	.19	-	2.20	-	1.50
	SOUTH	1.44		-		-		.02		.59	.25		.64	-	.48	-	1.16	-	1.72
TAC FIGHTER WING	G.B.	1.52	1.61	-	.73	.09	.35	.06	.28	.28		.06		.03	1.47	.50	1.18	.63	.46
	FRG	2.19	.43	-	1.65	.10	.22	.06	.38	.03		.60	.02	.02	.73	.14	3.54	.14	.13
	SOUTH	1.44		-		.12		.02		.59	.62		.17	.17	1.59	.88	.02	1.30	.46
TAC RECON WING	G.B.	1.12	.69	.06	.71	.04		.14	.16	.16		.21		.01	1.70	.45	.53	.78	.10
	FRG	.53	.07	.04	.10	.05		.10	.19	.04		.06	-	-	.17	.10	1.21	.06	-
TAC AIRLIFT WING	G.B.	.38		.15	.19	.06	.05	.02		.05		.05		.08	.86	.55	.03	.32	.54
	FRG	2.29	.09	.20	.19	.06	.05	.02		.05		.67	.08	.08	3.19	.76	1.69	.35	.59
TAC TRNG. WING	SOUTH	.41	.39	.09	.22	.22		.27		.12			.06	.05	.25	.52	.27	.21	.03
TAC GROUP	FRG	1.09	.41	-	.12	.06	.02	-	.13	-		.13		.01	.64	.15	.22	.09	.22
	SOUTH	1.09	.41	-	.10	.03		.02		.13	.13			.02	.64	.24	.22	.29	.27

Figure 5-10. USAF Generic Force Element Busy-Hour Traffic Matrix (In Erlangs)

Table 5-3
USAF Adjustment Factors

Force Element	CCS/Class "A" Line
USAFE Headquarters	−1.1
Numbered Air Force Hq.	+1.0
Tactical Fighter Wing (Ger)	+1.0
Tactical Fighter Wing (U.K.)	None
Tactical Fighter Wing (South)	−0.8
Tactical Reconnaissance Wing	−0.5
Tactical Airlift Wing	−0.3
Tactical Training Wing	−0.2
Tactical Support Squadron	−0.2
Non-USAFE	+1.1

6.0 U.S. Army Models

As previously discussed, the U.S. Army in Europe does not lend itself to generic classification due to the fact that it is primarily "in garrison" while using the DCS. Further, the overwhelming bulk of the U.S. Army in Europe is concentrated in the Federal Republic of Germany, where the Army-managed DDD is the primary common-user voice system. Less than twenty-five percent of the over one-hundred U.S. Army bases in West Germany directly connect to the AUTOVON system.

AUTOVON for the Army, then, is reduced to providing out-of-country calling capability and DDD/VF Dial backup for interservice calls with a DDD alternative between connected Army locations. Since non-directly connected Army bases must connect to AUTOVON through a terminated base, reached via DDD or ringdown trunks, and since there is no TDCS equivalent in the DDD to determine the origin of AUTOVON traffic, traffic seen by the TDCS in AUTOVON may have originated at any one of a number of Army bases.

6.1 U.S. Army AUTOVON Matrix

The U.S. Army AUTOVON matrix was developed in accordance with the process defined for the USAF in Sections 5.1.1, 5.1.4 and 5.1.5.1 of this report. The primary difference is that, except for Harrogate, Vicenza and Leghorn, the true point of origin of PBX traffic is unknown. Further, changes in the procedures by which non-connected bases reach AUTOVON connected bases will impact the TDCS perceived traffic volumes and patterns. The traffic matrix presented in Figure 6-1, then, represents the AUTOVON offered traffic as it was measured for the existing accessing configuration. Abbreviations used are explained in Table 6-1.

6.2 DDD

A description of the Army service observing equipment employed during this study, associated data processing techniques and results are provided in Appendix B. Since data was only obtained from nine trunk groups/groups of subscribers, out of the entire DDD system, no conclusions could be reached and no matrix developed. Samples of the results of the processing of the data are provided in Appendix B.

6.3 Alternate Traffic Volume Estimation Method

There was no CCS/Class "A" line estimate proposed for the Army as there was for the Air Force and Navy. When data on total long-distance traffic per base becomes available, the development of this figure should serve to confirm and verify the figures developed for the other services.

Table 6-1
Abbreviations Used in Figure 6-1

AUG — Augsburg	KLN — Kaiserslautern
BAI — Bad Aibling	LAN — Landstuhl
BKR — Bad Kreuznach	LEG — Leghorn
BRE — Bremerhaven	LKF — Langerkopf
BRU — Brussels	MAM — Martlesham Heath
BTO — Bad Tolzge	MAN — Mannheim
BUR — Burtonwood	MAS — Massweiler
CTO — Coltano	MOH — Mohrigen
DON — Donnersberg	MTP — Mt. Pateras
ELE — Elevsis	MTV — Mt. Vergine
EVE — Evere	MUN — Munich
FEL — Feldberg	NEC — Neckarsulm
FRT — Frankfurt	NUE — Nue Ulm
FUL — Fulda	NUR — Nurnberg
GAB — Gablingen	PIR — Pirmasens
GIE — Giessen	OBE — Oberursl
GOE — Goeppingen	RUP — Rupertsweiler
HAR — Harrogate	SCH — Schoenfeld
HDL — Heidelberg	STU — Stuttgart
HIN — Hillignon	VIC — Vicenza
HOH — Hohenfels	WOR — Worms
HUM — Humosa	WUR — Wurzburg
Kar — Karlsruhe	ZWE — Zweibrucken

	AUG	BAI	BKR	BRE	BRU	BTO	BUR	CTO	DON	ELE	EVE	FRT	FUL	GAB	GIE	GOE	HAR	HDL	HOH	KLN	KAR	LAN	LEG	MAN	MAS
ANSBACH																		.01							
AUGSBURG	.04			.07				.13				.13			.01			.08		.03	.02		.01	.02	.01
BAD AIBLING								.01									.01								
BAD KREUZNACH	.12		.12	.04					.13			.79			.04			.11		.08				.31	
BONN			.02					.03				.15						.01					.01		
BREMERHAVEN	.03		.02	.01								.35			.05			.34		.72				.52	
BRUNSSUM																		.07						.04	
BAD TOLZGE																									
BURTONWOOD	.03											.12					.03	.13		.46				.15	
COLTANO	.02							.01	.01			.04		.01				.02		.04			.01	.01	
DARMSTADT			.05	.04				.07				.22			.01			.65		.57				.45	.04
DONNERSBERG			.09	.04				.04	.67			.46		.01	.01	.03		.03		.95		.01		.25	.06
EVERE																		.05		.03				.03	
FRANKFURT	.01		.02	.09			.01	.01				.03			.01			.20		.15				.12	.02
FULDA	.02		.02	.01					.01			.16						.11							
GABLINGEN								.17	.01			.01		.01				.01							
GIESSEN	.05		.02	.13								.05						.50		.22				.24	.02
GOEPPINGEN						.01						.01						.05							
GRAFENWEHR									.04									.35	.04						
HARROGATE							.01		.01					.01				.01		.02				.01	
HEIDELBERG			.01	.02					.03		.02	.07		.02				.01		.03					
HOHENFELS				.07								.01						.01			.01				
KAISERSLAUTERN	.02		.01	.38			.02	.02	.20			.21			.01			.12					.02	.60	
KARLSRUHE	.22			.10								.04		.01				.01		.01				.06	
LANDSTUHL									.07								.03							.53	
LEGHORN	.05		.02	.01				.05				.66		.01	.02			.15		.26			.07	.23	
MANNHEIM	.02		.05	.22			.04		.04			.21			.02			.01		.77	.01		.01		
MASSWEILER	.01								.06			.08						.12		.01				.12	
MOHRINGEN				.01	.04							.01						.14						.01	
MUNICH	.02				.16			.02	.02			.52		.01	.02			.06		.06			.04	.10	
NECKRSLM												.01								.05				.01	
NUE ULM																									
NURNBERG	.08		.04	.28					.01			.03			.02			.05		.19			.01	.15	.01
PIRMASENS			.01	.33				.02	.04			.15		.04	.01		.01	.19		.03			.01	.03	
OBERURSL			.01	.05								.10						.14		.39			.08	.03	
RUPERTSWEILER																								.04	
SCWBSCGM																		.16							
SCHWEITZENGEN																									
STUTTGART				.05				.05				.03						.03			.02		.02		.02
WORMS	.03			.01			.01	.06	.14			.09	.01				.02	.09		.09			.14	.01	.01
WURZBURG	.01		.02	.14								.02			.01			.21		.02				.19	
ZWEIBRUCKEN	.02			.03			.01					.13			.30			.05		.01			.02	.07	.01
VICENZA	.19		.01	.08	.02		.02	.05	.02	.01		.29			.03			1.98		.55			.03	.30	

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	LEG	MAN	MAS	MOH	MUN	NEC	NUE	NUR	PIR	OBE	RUP	SCH	STU	WOR	WUR	ZWE	VIC	CONUS	CTO	DON	FEL	HIN	HUM	LKF	MAM	MTP	MTV	SCH	TOTAL
																				.07	.08								0.16
	.01	.02	.01		.01			.09	.01				.07	.08		.08	.03	.43	.01	.09	.29	.01		.01				.01	1.78
									.02									.02			.01	.01							0.10
		.31			.26			.20					.03		.07	.05				.26	1.12			.39	.15			.02	4.29
	.01				.01													.01		.10		.02						.03	0.39
		.52			.14			.15					.08	.15	.03	.12		.09		.21	.37	.06		.12			.01	.01	3.58
		.04			.01								.04				.03			.13	.03		.01					.12	0.48
																				.01									0.01
		.15			.01										.08	.01						.15			.43				1.60
	.01	.01											.09	.03	.01		.01		.05	.10	.03	.01	.06	.03	.01	.06	.10		0.76
		.45	.04		.01								.21	.01	.01	.12			.02	.24	.20				.01			1.16	4.09
01		.25	.06		.01			.02	.01	.03	.02	.03	.05	.43				.57	.69	1.47	.36	.09	.23	.09	.18		.23	.04	7.20
		.03		.01									.02	.01	.01			1.62		.01	.05	.12		.02	.01			.02	2.01
		.12	.02		.06			.02	.02				.06			.06		1.18	.01	.33	.30	.11	.02	.30	.04	.02	.01	.27	3.48
													.02	.01		.01				.03	.10			.14				.01	0.65
					.03				.02				.07	.02				.21	.12	.03	.18	.08		.21	.03		.01		1.22
		.24	.02		.13			.06					.02	.02	.18	.21				.10	.21			.08				.06	2.30
																				.04									0.11
													.01							.05	.06			.01			.01	.01	0.58
		.01			.01				.01					.03		.04				.01	.01	.37			.12				0.67
					.01				.02									3.45		.44	.44	.05			.03				4.65
																					.01								0.11
	.02	.60			.01			.03					.01		.02	.03	.09	1.15	.09	.34	1.03	.10	.14	.14	.12	.19	.03	.37	5.50
		.06			.01			.05					.05	.01						.07	.06			.01					0.71
		.53											.01							.09	.08						.02		0.83
	.07	.23			.13			.15	.01	.01			.07	.25		.25	.13	.38	.83	.09	.45	.09	.01	.05	.07	.06	.75	.01	5.32
	.01				.04			.09	.01				.01	.01	.05	.13	.11	.85	.02	.20	.42	.13	.10	.27	.04	.09	.12	.06	4.15
		.12			.04			.04					.06	.13		.01		32		.02	.03			.01	.01			.01	1.08
		.01						.02							.05					.03	.03			.22		.01			0.57
	.04	.10						.24	.02				.11	.01	.33	.07	.02	.83	.01	.26	.58	.06	.02	.19	.08	.27	.01	.12	4.26
		.01			.03								.17		.01	.01				.02	.01								0.32
																				.02									0.02
	.01	.15	.01		.18			.01	.10				.06	.01	.01	.38	.04	.73		.05	.51		.01	.35		.03	.01	.02	3.37
	.01	.03			.24			.35					.12			.16		.88	.12	.89	.36	.19	.06	.33	.18	.14	.23	.01	5.13
	.08	.03			.01			.03		.04			.05	.02	.04		.03	.79		.01	.21	.07		.12	.01			.01	2.24
		.04														.01													0.05
						.18	.18	.22					.01	.01						.01					.01				0.87
																		.31											0.31
	.02		.02		.03			.03							.05			.96	.18	.10	.28	.02		.58			.02	.12	2.59
	.14	.01	.01		.01			.02	.02				.03	.03	.02	.02	.07	2.51	.02	.37	.23	.10	.01	.10	.01	.07	.08	.03	4.46
		.19			.18			.02	.01				.07	.01		.18				.15	.27			.24				.04	1.79
	.02	.07	.01		.03			.11					.12		.06	.05	.03	.26		.10	.12	.02	.01	.08	.03	.01	.04	.02	1.74
	.03	.30			.48			.21					.12	.14	.07	.26		.66	.11	.22	.28	.08	.03	.39	.02	.87	.28		7.80

Figure 6-1. U.S. Army Busy Hour AUTOVON Traffic Matrix (In Erlangs)

7.0 U.S. Navy AUTOVON Model

The Navy in Europe, consisting of a small number of widely scattered, unique basis, also does not lend itself to generic classification. Unlike the other services, however, the Navy relies exclusively on AUTOVON for its common-user voice needs. Therefore, the AUTOVON model for the Navy also represents its total common-user voice requirements.

The AUTOVON model for the Navy was prepared in the same manner as the USAF Base-to-Base model, described in Sections 5.1.1, 5.1.4 and 5.1.5.1 of this report. The results are presented in Figure 7-1 with the abbreviations explained in Table 7-1.

7.1 Alternate Traffic Volume Estimation Method

In the same manner as used for the Air Force, the relationship between total offered traffic and Class "A" phones was established for the Navy. The relationship for the U.S. Navy, however, is 1.3 CCS/Class "A" line.

Table 7-1
Abbreviations Used in Figure 7-1

AGN — Agano	LKF — Langerkopf
BAH — Bahrain	LDY — Londerderry
BRA — Brawdy	LON — London
BRI — Brindisi	MAD — Madrid
CAP — Capodochino	MAM — Martlesham Heath
CTO — Coltano	MTP — Mt. Pateras
DON — Donnersberg	MTV — Mt. Vergine
EDZ — Edzell	NAP — Naples
FEL — Feldberg	NEA — Neamakri
GAE — Gaeta	ROT — Rota
GLA — Glasgow	SAN — San Stefano
HIN — Hillingdon	SCH — Schoenfeld
HOL — Holy Lock	SDB — Sandbank
HUM — Humosa	SID — Sidi Yahia
Kef — Keflavik	SIG — Sigonella
KEN — Kenitra	STM — St. Mawgan
	THU — Thurso

	AGN	BAH	BRA	BRI	CAP	EDZ	GAE	GLA	HOL	KEF	KEN	LDY	LON	MAD	NAP	NEA	ROT	SAN
AGNANO	.03	.04		.01	.01	.01							.25	.02		.07	.25	.11
BAHRAIN	.10				.10								.05			.05	.19	
BRAWDY			.01					.01					.05					
BRINDISI	.01																	
EDZELL	.06					.06		.21	.17	.06		.30	.45		.08		.15	
GAETA													.05			.03	.03	
GLASGOW			.01			.03						.03	.03					
HOLY LOCH												.10	.01				.03	
KEFLAVIK						.01			.05			.03	.08		.01		.04	.01
KENITRA	.07												.16				.23	
LONDONDERRY						.02			.03	.02		.01	.07		.01	.01	.03	
LONDON	.75	.02	.06		.01	.12	.01	.12	.02	.14	.03	.07	.07	.03	.29	.01	.46	
MADRID	.03	.01											.12			.05	.05	
NAPLES		.01										.02	.17			.02	.13	.04
NORTHWOOD										.01			.01					
MCRNHNSH						.01			.17			.02	.03					
ROTA	.37			.01	.31	.04	.01		.02		.25	.01	.36	.14	.14	.03	.02	.01
SAN STEFANO	.02				.01									.05				
SANDBANK	.01					.01			.01			.07	.05				.01	
SIDI YAHIA	.03	.03					.03						.12				.57	
SIGONELLA	1.91				.32					.04	.06		.06	.02	.52		.73	
ST MAWGAN									.02			.04	.05					
THURSO						.02						.14	.08	.01			.07	

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ROT	SAN	SDB	SID	SIG	STM	THU	CONUS	CTO	DON	FEL	HIN	HUM	LKF	MAM	MTP	MTV	SCH	TOTAL
.25	.11		.01	.37			.71	.27	.35	.15	.01	.08	.05		.15	.13		3.08
.19				.05			5.29		.19	.10	.72	.05	.05					6.94
									.01		.05			.04	.01			0.18
																.01		0.02
.15		.11																1.65
.03				.03			.38											0.52
					.01									.02				0.13
.03							.33		.02	.10	.07		.01	.01		.01		0.69
.04	.01			.01			.84	.01	.03	.06	.07	.03	.02	.14				1.44
.23										.03		.03			.07			0.59
.03							.50											0.67
.46		.04	.14	.38	.05	.01	3.77		.73	.16	.43	.02	.12	.60	.06	.16	.01	8.89
.05				.07			.03	.01		.01	.03		.01	.01	.01			0.44
.13	.04			.16			.62	.08	.11	.06		.05	.08		.05	.11		1.71
							.10				.06							0.18
		.02			.04						.07		.01					0.37
.02	.01		.14	.85			.78	.27	.16	.17	.09	.57	.13	.01	.21	.09		5.19
							.08	.01	.01				.01					0.19
.01																		0.16
.57			.03						.09	.03		.33						1.26
.73				.59			2.50	.31	.10	.46	.02	.23	.02	.04	.29	.86		9.08
									.05	.01	.12	.01	.04	.03			.01	0.38
.07				.01			.56				.03	.01		.03				0.96

Figure 7-1. U.S. Navy Busy-Hour AUTOVON Traffic Matrix (In Erlangs)

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8.0 Other Command Locations

There are a number of locations in Europe which do not fall under any one of the three previously discussed MILDEPTS. USEUCOM at Vaihingen is a unified command while others are NATO locations; locations jointly serving the Army and Air Force such as Berlin, whose traffic cannot be segregated; and State Department locations. These locations do, however, generate AUTOVON traffic, and in some cases substantial amounts. These other locations, whose traffic was analyzed as described in Sections 5.1.1, 5.1.4 and 5.1.5.1, are presented in Figure 8-1 with abbreviations explained in Table 8-1.

Table 8-1
Abbreviations Used in Figure 8-1

ANK — Ankara	MAM — Martlesham Heath
AVI — Aviano	MAN — Mannheim
BER — Berlin	MLD — Mildenhall
BIT — Bitburg	MTL — Mt. Limbari
BKR — Bad Kreuznach	MTV — Mt. Vergine
BRU — Brussels	MUN — Munich
CRO — Croughton	NAP — Naples
CTO — Coltano	NUR — Nurnberg
DON — Donnersberg	PIR — Pirmasens
FEL — Feldberg	RAM — Ramstein
FRT — Frankfurt	RHE — Rhein Main
HAN — Hahn	ROT — Rota
HEI — Heidelberg	SCH — Schoenfeld
HUM — Humosa	SEM — Sembach
KAI — Kaiserslautern	TOR — Torrejon
LIN — Lindsey	VAI — Vaihingen
LKF — Langekopf	WOR — Worms
LON — London	

	ANK	AVI	BER AR	BER AF	BIT	BKR	BRU	CRO	CTO	DON	FEL	FRT	HAN	HEI	HUM	KAI	LIN	LKF
BERLIN	.01		.07	.10	.03	.01	-	.02	.01	-	.19	.08	.03	.36	-	.29	.31	.03
BRUSSELS	-	-	-	-	-	.01	-	-	.03	-	-	.09	-	-	-	-	.02	-
CASTEAU	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	-	.02	.02	-
CHELTINGHAM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHIEVRES	-	-	-	-	-	-	.01	-	-	-	-	-	-	-	-	-	-	-
KINDSBACH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LINDSEY WIESBADEN	.19	.36	.04	.03	.28	.53	-	.12	.01	.04	.09	1.54	.29	.99	-	1.99	.02	.01
MORMOND HILL	-	-	-	-	-	-	-	.02	-	-	-	-	-	-	-	-	-	-
PARIS	-	-	-	-	.01	-	-	-	-	-	-	-	.01	-	-	.01	.01	-
SHAPE	.03	.03	.07	-	.01	.01	-	.09	.01	.13	.04	.24	.04	.03	.01	.07	.04	.02
VAIHINGEN	.03	.01	.04	.01	.03	-	.01	.07	.02	.04	.02	.18	.03	.17	.01	.11	.13	.02
VIENNA	-	-	-	-	-	-	.01	-	-	-	.01	.01	-	-	-	-	-	-

	LON	MAM	MAN	MLD	MTL	MTV	MUN	NAF	NUR	PIR	RAM	RHE	ROT	SCH	SEM	TOR	VAI	WOR	CONUS	OTHER EUR
BERLIN	-	-	.14		-	-	.13	-	.08	.01	.45	.51	-	-	.13	-	.12	.02	.40	.51
BRUSSELS	.02	-	-	-	-	-	.02	-	-	-	-	.13	-	-	-	.01	.03	-	.16	.04
CASTEAU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CHELTINGHAM	-	-	-	-	-	-	.01	-	-	-	-	-	-	-	-	-	-	-	.01	.01
CHIEVRES	-	-	.03	-	-	-	-	-	-	.02	-	-	-	.01	-	-	-	-	-	.31
KINDSBACH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.03	
LINDSEY WIESBADEN	.03	.01	.18	.09	-	.01	.17	.04	.25	.02	.47	.02	.13	.02	.56	.41	.66	.01	1.02	4.05
MORMOND HILL	-	-	-	.03	-	-	-	.01	-	-	-	-	-	-	-	-	-	-	-	.02
PARIS	-	-	-		-	-	-		-	-	.01	-	-	-	-	-	-	-	-	.04
SHAPE	.01	.01	-	-	.01	.01	.03	.10	.07	.05	.33	.03	.03	.37	.03	-	.10	.03	.21	.45
VAIHINGEN	.24	-	.06	.07	-	.04	.14	.08	.04	.02	.46	.13	.06	.01	.03	.05	.06	.05	.86	.85
VIENNA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	.01	-	.18	-

Figure 8-1. Other Commands' Busy Hour Traffic Matrix (In Erlangs)

9.0 Summary and Conclusions

9.1 Introduction

The principal goal of the European Traffic Flow Study has been the derivation of traffic projection programs describing generic force elements making use of DCS facilities within Europe. As described in previous sections, the organization of forces, the local environment and the behavior of communication networks supporting these forces have resulted in conclusions which vary from those desired in form, yet will ultimately support the original objective — a predictive capability for the determination of traffic flow.

In addition, substantial quantitative understanding of DCS behavior, particularly in the case of AUTOVON, was determined during the course of the study. This understanding has led to other study conclusions and recommendations which have the potential for improvement in system performance within the practical constraints of existing policy, technology and cost.

The following sections discuss these conclusions, divided into areas of traffic projection, traffic measurement, and network performance.

9.2 Traffic Projection

Study results in terms of traffic projections are provided in detail in Sections 5, 6 and 7 for the Air Force, Army and Navy respectively. For the Air Force, a generic force element presentation has been supplied. For the Army and Navy, traffic flow between Army installations and between Navy installations has been provided. Section 8 provides base-to-base traffic flow for joint commands and other users.

The form of these presentations has been determined by three factors which have had a major effect in establishing the nature of all work performed during the study and the results. These factors are force organization, network behavior and the local environment.

In attempting to define a basic set of generic force elements into which the various Military Departments could be divided, it became quickly apparent that a division would be required between each of the three major departments; Air Force, Army and Navy. The mission of each department and its use of the DCS varied sufficiently between each organization to make this division necessary at the beginning of the study. Findings during the program ultimately indicated that these differing factors would not permit a force element view of two of the services, the Army and Navy.

The Air Force has the primary mission of operating and supporting aircraft from a large number of bases within Europe. Examination of these bases indicated that the number of personnel employed to support these facilities in all respects (base support and aircraft support) varied but a relatively small amount, basically

independent of the number of aircraft at a particular location. Personnel variations tended to vary more as a function of the country in which the base was located. Bases in Germany tend to have more base support personnel than those in the United Kingdom since German bases are totally U.S. manned and operated while the Air Force in the United Kingdom tends to be a tenant on RAF facilities. The Air Force in Germany also makes substantial use of Army support in personnel matters — recreation, education, dependents, etc.

In terms of organization and the search for meaningful force elements, the Air Force was found to exhibit a regular pattern of organization which was repeated at almost every location. This structure is described in Section 4. A key finding however was the fact that few of these force elements could be considered realistically as a separate unit for traffic projection purposes. For example, an Air Force squadron might be felt as a suitable force element category; but when examined further, the squadron organization is found to consist of flying personnel and other specialized ratings which comprise in total only about 2% of base personnel. Little communications was found directed to this element, and it is clear that the group identified as "squadron" is not capable of independent movement in terms of impacting the DCS. Squadrons are relocated temporarily for maneuvers and crisis situations, but they require support of a level provided at their primary base in terms of maintenance, supply and the other activities needed to keep any base operational. These factors all pointed to the selection of an Air Force Wing as a force element, and in fact probably the only meaningful one to survive the tests of capacity for independent movement and significance of communications volume.

In addition, the Air Force forms the major user of AUTOVON within Europe and with the exception of specialized networks such as VF Dial and Ringdown uses AUTOVON for about 60% of its common-user communications.

The U.S. Army was found to exhibit a completely different picture. The basic Army mission, fielding troops for combat, implies that in action, the Army employs tactical communication systems basically divorced from the DCS. When not in action, or on maneuvers, Army forces are located in large garrison facilities where the major activity is just support. The environmental effect here is the reality that there are no generic garrisons. Garrisons exist where the facilities (housing and transportation) can be reasonably located, near to where the troops will be needed but not in a standard form such as exhibited by the Air Force.

In addition, Army administrative common-user voice communications is handled almost completely by the DDD network within Germany. AUTOVON is employed on a restricted basis, for overseas calling and by use of senior personnel within Europe.

The U.S. Navy presents a similar picture to that displayed by the Army. The Navy mission of fleet operation and maintenance implies that the majority of naval

communications are carried out between shore stations and ships at sea. Much of these communications employ AUTODIN for the transmission of record traffic, a traditional Navy ship-to-shore communication form. Within Europe, only a small number of bases or facilities are found, basically ports with the capability for ship repair and maintenance, or major headquarters such as USNAVEUR in London. With this type of organization and operation, generic force elements cannot be defined since the small number of facilities per se include many different types of organizations.

These studies and resultant observations indicate that a generic force element view of the military departments, while desirable from a forecasting standpoint for DCS engineering cannot be supported in fact due to the nature of force organizations and the environment (country) into which the forces are placed. The type of Host-Nation agreements, proximity to other U.S.forces and other factors appear to have major influence upon the flow of traffic.

The study objective, to provide a forecasting or predictive capability, does appear practical however, but based upon a different view of the situation. In particular, the use of CCS per Class A telephone seems to provide a relatively dependable measure of offered traffic based upon detailed examination of Air Force data. This factor, found to be 1.7 CCS/Class A phone for the Air Force for off-base traffic compares reasonably with the range of 2-5 CCS/main station in the commercial world. It is believed that the figure would be higher if subscriber experience indicated a higher probability of call completion. This "missing" traffic we have called suppressed traffic since it represents a real demand for service that will appear if system performance were improved.

Measurement at Navy installations indicated a 1.3 CCS/equivalent Class A telephone factor. Utilization for an Army telephone was not determined during this study due to a lack of data. It is expected however, that a value somewhat between the Air Force and Navy factors will be generated by this service.

This approach (CCS/main station or Class A phone) for sizing switches and transmission capacity is routinely employed by commercial telephone companies and provides sufficient accuracy to ensure reasonable service. Variations from an average figure are compensated for commercially by service measurement after service cutover to account for the peculiarities of each customer at a particular location.

9.3 Traffic Measurement

During the European Traffic Flow Study, three sources of traffic data were employed to establish calling patterns and traffic cross section. These included the AUTOVON Traffic Data Collection System, U.S. Army service recording equipment (VAM) and U.S. Air Force traffic studies. These sources all provided valuable information and will be important in the future for further traffic flow studies and for basic network management efforts.

Substantial computer software was developed during the study as described in Appendices A and B for reduction of both TDCS and VAM data on a routine basis. This processing ability represents one of the major results of the study, providing the basis for future quantitative examination of network behavior.

From the standpoint of DCA studies and network management, additional data was found necessary and was obtained in part during the program through the cooperative efforts of the DCA and military departments. In particular, counts of:

a. ATB conditions for base subscribers attempting to reach AUTOVON access lines, and
b. Called-party busy when reached through an inward dialed AUTOVON call

if taken routinely would permit a broader based view of demand and blockage than could be obtained from the samples taken during this study. Specific measurement of usage on off-base circuits would permit a more accurate estimate of CCS/telephone than was possible using data available during the program. These types of data have wide potential use in substantiating military department service requests and for DCA use in evaluating and controlling network performance. This joint value suggests some routine cooperative collection of this type of information.

At present, Air Force studies as accomplished regularly by the Northern Communications Area of the Air Force Communication Service provide considerable information relating to base telephone service. The additional data suggested above could be obtained during these studies as some were upon our request during this program.

TDCS and VAM data provides a wealth of information both for study use as well as for day-to-day planning and management. Army VAM equipment, while providing valuable insight into DDD network performance, requires some enhancement before more general application.

9.4 Network Performance

A key issue in directing the course of study investigations and activities was the performance of the voice common-user networks employed by subscribers in Europe. These networks included the AUTOVON and DDD.

In providing traffic projections, or traffic in the form of CCS/Class A telephone, it was clear at the program start that the only meaningful traffic quantity could be offered traffic. In a commercial system, offered traffic and carried traffic are assumed to be nearly identical, for the reason that the telephone systems are designed with sufficient capacity to obtain that characteristic.

Study of AUTOVON and DDD traffic information indicated that more traffic was being offered to these networks that they were carrying. This was evidenced by:

a. High occupancy of AUTOVON PBX trunks: over 60% outgoing on many two-way trunks during most of the business day.
b. A large number of short holding times calls: 46% of AUTOVON calls having a holding time of 25 seconds or less.
c. Many repeated attempts to the same number in a short period of time.

Item (a) indicates that more traffic was being placed on the AUTOVON than it was capable of off loading: two-way trunks are often viewed as being used 50% in each direction, a fact that was not found routinely in the study.

The AUTOVON, viewed in these terms, is access line limited. Subscribers dial repeatedly in the hopes of obtaining a line, and the effect of this action is to occupy access lines and trunks in passing busy signals and short holding time (incomplete) calls about the network. Attempts to improve the situation at any one base are unsuccessful since the problem is common to all bases, an insufficiency of access lines where a small increase at one location has basically no effect overall.

Similar action takes place at European gateways where the small number (80-90) of transoceanic trunks form a chokepoint where many subscribers compete for lines. Much network capacity is occupied here in a connection to an occupied gateway and then alternate routing to another gateway, only to find it busy as well. Much of this type of activity could be eliminated if data were sent between AUTOVON switches indicating occupancy of trunk groups (both local and CONUS) to prevent calls being forwarded to switches and trunks which are completely occupied.

These factors have led to the studies provided in Appendix D where offered traffic in a congested network is estimated from the carried traffic and some estimates of subscriber behavior concerning call reattempts.

Some comment is needed here concerning the terms "insufficient number of access lines", "grade-of-service" and other measures or implication of performance. A meaningful definition can be based only upon the type or level of service that is desired by the network managers. To the routine user of AUTOVON, performance could easily be rated as inadequate, but only with respect to what that user has been offered in terms of his commercial experience. The AUTOVON is primarily a command and control communication facility, with routine or administrative traffic filling up unused capacity when available. In those terms, it is the precedence user who requires a high grade of service — and this has been found to be the case on the average.

Data collected during the study indicates that about 28.6% of the AUTOVON calls originated in Europe are of precedence category above routine. Thus the majority of calls are routine in nature. It seems impractical and perhaps unreasona-

ble to provide sufficient access lines and other equipment to provide a commercial grade of service for routine subscribers: but in any case, the distinction must be preserved and reserved to those who establish DCS policy. What this study has indicated is that basically within the constraints of present funding and policy, improvement in service can be obtained with a number of relatively inexpensive techniques.

These include:

a. The thought that access lines should be provided on the same cost basis as present, but with a ratio of one-way incoming lines to two-way lines established to ensure that the calls that reach the network can leave the network.
b. That AUTOVON switches be interconnected to indicate if destination trunks are busy, and thus prevent network capacity from being used to pass inherently unsuccessful calls.*
c. Considerations of rehoming selected bases to switches where the majority of their traffic is destined. Ramstein AFB is a particular example with its heavy CONUS calling coupled with the requirement that every overseas (CONUS) call from Ramstein pass through at least one tandem switch. This is not a step to be taken lightly due to overall interswitch trunking and survivability impact, but the process should be examined.
d. Addition of trunks between AUTOVON switches where traffic data indicates that heavy traffic cross sections exist: as in commercial operations, such high usage trunks would markedly improve performance and reduce local congestion spots.

Another factor which appeared during the study concerned the behavior of subscribers in calling system operators. Approximately 50% of all AUTOVON calls in Europe were placed to an operator. In some cases, these calls were destined to locations which had no direct inward dialing capability but the majority were placed to facilities where this feature was available. Only an average of 32.5% of these calls were at a precedence level above routine; thus, we can conclude that calls were placed to an operator because the user did not know the specific number to be called. Potentially, a consolidated European telephone directory could improve this situation. As described in Appendix G, a consolidated AUTOVON directory has been prepared for the Air Force in Europe and implemented in a computer-based form. This type of approach offers the basis for a more general consolidated directory which could substantially reduce operator calling in the network.

From the study's standpoint, these operator calls could not be traced to the destination organization, thus preventing complete definition of calling patterns.

*In a complete form, this approach is seen as common channel signaling. Full CCS implementation is not required, however, for just a trunk occupancy indication.

9.5 Summary

The European Traffic Flow Study has indicated the potential for forecasting or predicting DCS traffic requirements but in a manner not anticipated at the start of the program. Basically, use of a figure describing offered traffic in terms of CCS/ Class A telephone line has been seen to provide the desired relationship between subscribers and traffic handling capacity.

In addition, network studies required to reach this conclusion have disclosed a number of factors which can potentially lead to improvement in network performance within the constraints of current policy and funding.

10.0 Recommendations

Study conclusions discussed in the previous section result in a series of recommendations which are directed to:

a. Verification and enlargement of an ability to project DCS traffic based upon subscriber characteristics, primarily in the form of a derived offering of CCS per main or Class A telephone.

b. Additional studies of observed network performance characteristics to determine the practicality for network improvement within policy and cost limits.

Recommendations in these two categories are provided in the following sections.

10.1 Traffic Projection

European Traffic Flow Study findings have indicated that a measure of CCS per Class A telephone provides a sound basis for estimation of traffic generated by a Military Department facility. This finding is based upon observations of Air Force traffic where a value of 1.7 CCS/Class A telephone represent a mean value for offered traffic.

This figure represents 20 Air Force bases and include the majority of Air Force personnel in Europe. Navy traffic offering was determined to be 1.3 CCS/Class A telephone based upon data describing the three major Navy facilities in Europe; London, Rota and the Naples complex. In order to verify the broad use of such a factor for DCEC engineering purposes, the following specific recommendations are suggested:

1. Supplement the Army AUTOVON data collected during the study with additional information from that service to determine off-base offered CCS per Class A telephone. These data should then be compared with European Air Force and Navy estimates to establish a set of characteristics for European DCS use.
2. As U.S. Army service observing equipment (VAM) routinely provides data describing the DDD in Germany, use this information to develop call data for subscribers connected to this common-user administrative network.
3. With suitable service recording equipment, institute a test program at other locations where in-country common-user systems provide the majority of administrative telephone service, specifically Japan and Korea. These tests should be directed toward the determination of offered traffic per equivalent main station for comparison with European DDD information.
4. Determine AUTOVON offered CCS/Class A telephone in the Pacific employing TDCS measurement and local base collection of data such as provided by the Air Force under this study. Data here for the three services can then be compared with European experience to complete a world-wide set of data for both the AUTOVON and in-country networks and validate use of these data for DCEC system engineering activities.

5. Consider the use of 1.7 CCS/Class A telephone for forecasting purposes when dealing with Air Force requirements and 1.3 for Navy application. These figures, for offered traffic, clearly represent the European experience and are expected to provide a level of accuracy sufficient for present DCA engineering purposes.

Routine updating of these data can be provided through an extension of the procedures established during this study and followed during the above continuation activities.

10.2 Network Performance Characteristics

Studies of the AUTOVON and DDD in Europe were required during this program to determine offered traffic due to the congested nature of these networks. These studies have provided the first quantitative measure of various aspects of network performance, resulting from this first extensive use of the AUTOVON Traffic Data Collection System and Army service observing data. A number of recommendations follow from these observations:

1. Continue engineering use of both TDCS and Army (VAM) data by DCEC on a routine basis. The wealth of information available only from these sources has proven of substantial value in the European Traffic Flow Study. Examinations of various additional types were suggested during this study but could not be accomplished due to limits of funds and time.
2. Investigate the mix of one-way incoming and two-way PBX access lines to determine if a change in the ratio of these facilities are required to ensure an adequate ability to off-load traffic placed on the network. This examination should ultimately be directed toward providing a uniform access line policy so that each base can be provided access lines up to a level that will ensure comparable call completion rates for each location.

   These completion rates must be adjusted for local peculiarities such as heavy CONUS calling where other factors come into effect. Since network performance in the systems is limited by access line quantity at PBXs, the number and type must be judged on a system basis; arbitrary changes at any one base will not appreciably change performance at that base since inability to complete a call at the destination is the limiting factor. In effect, within funding limits and policy requirements, everyone can potentially be provided with similar service levels, or alternatively, add one-way incoming lines to bases which receive a heavy traffic offering, Ramstein for example. An improvement here in the completion of incoming calls should produce a general improvement overall.
3. Investigate observed network effects for their potential in exposing improvements in system performance. These effects include the large number of short holding time calls and the large number of calls placed to operators.

4. Study the potential for service improvement in interconnecting AUTOVON switches from a signalling standpoint to prevent calls that cannot be completed from leaving the originating switch.
5. Consider other potential network improvements including rehoming of selected bases and the addition of heavy usage trunks where traffic patterns indicate the need for this type of relief.

This European Traffic Flow Study has provided substantial insight not only into the means and techniques for traffic prediction but into the behavior and potential improvement of system performance. The ultimate scope of this study has indicated the present availability of substantial system data to support efforts in these directions. In addition, the cooperative efforts of all Military Department personnel in supporting this study indicates that sound, common engineering policies derived from these data will meet with general support in providing the best service possible for available funds.

Appendix A
AUTOVON TDCS Data

1.0 Introduction

The AUTOVON Traffic Data Collection System (TDCS) became operational in Europe as this study began, and provided the bulk of the data used in this study. As with all new systems, there were a few difficulties encountered some of which were unique to a particular site and some of which applied to all sites. One site, at Mt. Pateras, has yet to become operational and provide the Call Data required for this study. Further, since the system is new and its data collection outputs are just beginning to be used, few analytic programs have been written. It was therefore necessary to develop the analytic software required to use the TDCS data for this study. This appendix will briefly describe the TDCS and the data reduction and analysis performed.

2.0 The TDCS

The TDCS has been installed at all overseas 490L AUTOVON switch sites and Area Communications Operation Centers in Stuttgart and Kunia. There are five functions accomplished by this system, which is built around the Lockheed SUE minicomputer:

1. Rapid Memory Reload-to reload the 490L memory quickly, when required.
2. Traffic Data Collection — to provide hourly count, duration and usage data to use in assessing switch and trunk performance and loading.
3. Call Data Collection — to provide data on each call reaching a switch (what trunk the call originated from, who the call was going to, how long it lasted, what outgoing trunk it was connected to, etc.) for use in curbing abuses and further analyzing system performance.
4. Communications — that allow the transmission of data between switch site units and an ACOC.
5. Control — that permits data collection functions at the switch sites to be exercised from the ACOC as well as locally, and allows further data retrieval from the switch sites.

There have been problems identified with each of the five functions. The ordering of the five in the list above is generally in the priority sequence that the identified problems are being resolved. The Rapid Memory Reload has been made fully functional. The Traffic Data Collection mode should be fully operational in December 1977. Resolution of Call Data Collection problems has started and planning has commenced for solving the last two functions' problems. Fortunately, none of the identified problems with the Call Data Collection function has been of a nature to adversely affect the Traffic Flow Matrices that are the primary output of this study.

3.0 Data Reduction Process

The AUTOVON data reduction process is used to take raw Traffic Data Collection Systems (TDCS) data and produce the computer reports necessary to characterize the network. The reduction process consists of three steps, described as follows:

1. Raw data quality tests to determine if the data is suitable for processing.
2. Data preprocessing, where raw data is assembled into call data.
3. Call data testing where mis-dialed digits and calls ending in vacant comde announcements are eliminated from the data base.

In addition, there is a report generating process that can operate on the preprocessed data to obtain required computer reports.

3.1 Raw Data Quality Tests

The traffic data collection system produces nine-track, 800 BPI tapes. Some of the tapes have as many as forty tape files per collection period. The tapes used for the European Traffic Study were obtained by GTE Sylvania and shipped to Needham, Massachusetts, for processing. It was necessary to subject these tapes to a series of tests to determine if the data was good enough for processing. Tapes have been rejected for the following reasons:

1. The tapes could not be read by the IBM tape drives.
2. The time of day and/or dates on the tapes were incorrect.
3. There were too many interrupts in the data collection period.

Several FORTRAN programs were created and used to test the tapes. One program translates the ASCII characters and produces a formatted dump of the first few records of each file on the tape. An example of this dump is shown in Figure A-1. The second program is used to consolidate all the raw data files onto one file for the following preprocessing program. It was found that even if there was noise on one tape file, other files could be processed.

3.2 Raw Data Preprocessing

When the raw data has been tested and consolidated onto one file it can then be preprocessed. The program for preprocessing the data is a Sylvania modified version of the DCA CADAPS program. The output of the preprocessing is a tape file of "Call Data".

The purpose of the preprocessing is essentially to combine each II entry with the corresponding RT entries. There is a one-to-one correspondence between II entries and records in the Call Data Base. The format of the Call Data records is shown in Figure A-2. The process of forming a call data record from an II entry is as follows:

1. The raw data is scanned for the RT entry corresponding to the originating trunk. If the RT is present, form the call data record using the release time of the originating trunk, and process the next II. If the RT entry for the originating trunk is not present, go to step 2.

```
RAW TRAFFIC DATA, PAGE     1 IO UNIT NUMBER
VONASREQCDC    SCHSCH   065914   04/18/1977    HH 06   ZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZ
ZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZ
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ZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZ
ZZZZZZZZZZZZZZZZZZZZZZ                             RT   5927   6800   RI   5927   8003

II   7601   4 0 4557733      6500   5931
II   8000   4 0 4511161      1303   5933   RT   5936   8000
II   8600   4 0 4557308      6501   5938   HH 07                RI   0004   6501

II   8002   4 0 4557308      6502   0033   RT   0108   7601   RI   0109   6500
II   8401   4 0 4541110      7602   0109   RT   0120   6502   RI   0121   8002
                                           RT   0132   8401
II   8403   4 0 4551110      6503   0144   RT   0145   7400   RI   0205   6503

II   2201   3 0 5932823      3700   0251
II   6800   4 0 6319823      8004   0334   RT   0407   2201   RI   0407   3700
                                           RT   0452   8004
II   8000   2 0 4541110      7600   0445
II   8400   4 0 4551110      6500   0527   RT   0546   6500   RI   0547   8400
II   8401   4 0 4551110      6502   0604   RT   0639   8000
II   7600                    1600   0659   RT   0754   7600
II   8001   2 0 4541110      7603   0738   ZZZZZZZZZZZZZZZZZZZZ
II   2225   4 0 453749       1300   0837   RT   0849   2225
II   8402   4 0 4537346      6300   0900
II   2225   4 0 4537496      6303   0905   RT   0917   7603   RI   0917   8001
                                           RT   094    8402   RI   1057   8003
II   8400   4 0 4531110      6301   1105
II   2207   4 0 4285112      8602   1233   RT   1239   2207   RI   1240   8602
II   2207   4 0 4288534      8600   1247   RT   1320   6301   RI   1325   8400
                                           RT   1334   8600
II   8403   4 0 4546364      7604   1400
II   8000   4 0 4537914      6302   1413   RT   1424   6302   RI   1424   8000
II   8001   2 0 4531110      6300   1429
II   8002   4 0 4531110      6301   1453   RT   1501   7604   RI   1501   8403
II   6800   4 0 6319823      8000   1504   RT   1511   8000   RI   1519   6502

II   6800   4 0 6319823      8003   1521   RT   1526   6800   RI   1527   8003
II   6800   4 0 6331110      8004   1538   RT   154.   6300   RI   1543   8001
ZZZZZZZZ
```

1

Figure A-1.

```
 1 IO UNIT NUMBER
5914    04/18/1977    HH 06    ZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZ
ZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZ
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ZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZZ
                 RT    5907   6800   RI   5927   8003   RT   5928   8001

   6500   5931
   1303   5933   RT    5926   8000
   6501   5938   HH 07                RI   0004   6501   RT   0004   8600

   6502   0033   RT    0108   7601   RI   0109   6500
   7602   0109   RT    0110   6502   RI   0121   8002   RT   0132   7602
                 RT    0132   8401
   6503   0144   RT    0145   7400   RI   0205   6503   RT   0205   8403

   3700   0251
   8004   0334   RT    0407   2201   RI   0407   3700   RT   0421   6800
                 RT    0432   8004
   7600   0445
   6500   0527   RT    0546   6500   RI   0547   8400
   6502   0604   RT    0629   8000
   1600   0659   RT    0704   7600
   7403   0738   ZZZZZZZZZZZZZZZZZZZZ
   1300   0837   RT    0849   2225
   6300   0900
   6303   0905   RT    0917   7603   RI   0917   8001   RT   0946   6300
                 RT    094    8402   RI   1057   8003
   6301   1105
   8602   1233   RT    1239   2207   RI   1240   8602
   8600   1247   RT    1320   6301   RI   1325   8400   RT   1333   2207
                 RT    1334   8600
   7604   1400
   6302   1413   RT    1404   6302   RI   1424   8000
   6300   1429
   6301   1453   RT    1501   7604   RI   1501   8403
   8300   1504   RT    1511   8000   RI   1519   6502   RT   1521   8401

   8003   1521   RT    1526   6800   RI   1527   8003
   8004   1538   RT    154    6300   RI   1543   8001   ZZZZZZZZZZZZZZZZZZ
```

Figure A-1. Raw TDCS Data Sample

2

2. The raw data is scanned for the RT corresponding to the terminating trunk. If the RT entry is present, form the call data record using the release time for the terminating trunk, and go to process the next II. If the RT is not present, go to step 3.
3. If neither RT is present, the call data record is formed with a blank release time, and a blank holding time. Then, process the next II.

A functional flowchart of the process of forming the call data records is illustrated graphically in Figure A-3.

Field Description	Starting Position	Length	Heirarchy of Sort
1. Originating TG/TK	1	2/4	3
2. Initial time	5	6	4
3. *Release time	11	6	—
4. Dialed digits	17	10	—
5. Precedence	27	1	—
6. Route	28	1	—
7. Terminating TG/TK	29	4	—
8. Originating switch	33	3	1
9. Blank**	36	3	—
10. Blank**	39	4	—
11. Blank**	43	3	—
12. Grade	46	1	—
13. Blank**	47	7	—
14. Date	54	6	2
15. *Holding time	60	6	—

* — These entries are blank if no RT is found for either originating or terminating trunk.

**— These fields are unused by the modified CADAPS. They are used later for force element directory information.

Figure A-2 – Format of Call Data Records

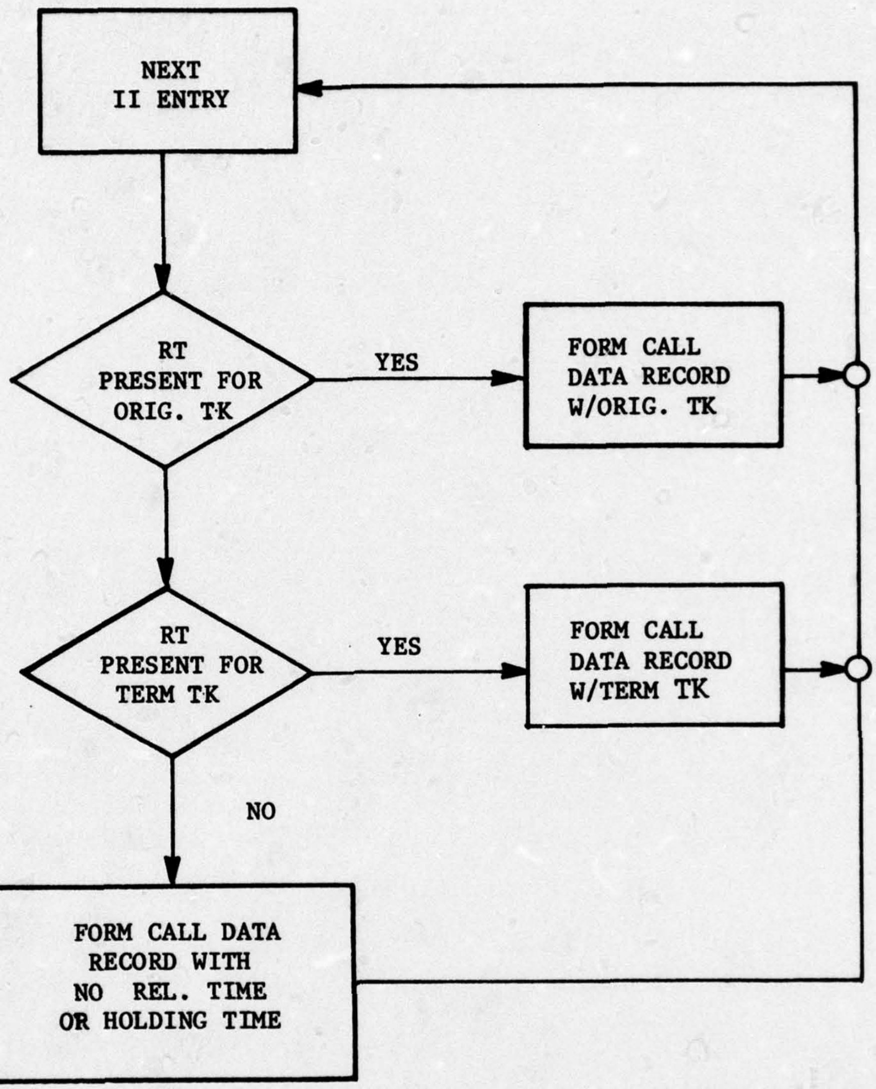

Figure A-3. Functional Flowchart of Data Preprocessing

3.3 Editing the Data Base

In order to perform the traffic analysis, an edited form of the data base was identified. The intent of this edited data base is to use only originating calls and calls that have correctly dialed digits. Information is then added to each record in order to satisfy the report needs.

The first step is to scrub out bad records, and records that are not originating calls. Therefore the following three criterion must be met to pass a record.

1. Calls that originate at the switch that the data was recorded. That is, calls whose originating trunk are inter-switch trunks are eliminated.
2. Call records that contain a full seven or ten-digit dialed number.
3. Intra-switch calls that do not terminate in vacant-code announcements.

All calls that satisfy these tests are placed into the edited data base. However, the data is further modified to satisfy the needs of the traffic study.

The precedence field in the call records is examined to determine if the calls are routine. Calls that are "priority", "immediate", "flash" or "flash override" are precedence calls. For these calls the characters "PRI" are added to positions 43-45 of the data base. For the routine calls, the characters "RTN" are placed into those positions.

Calls that originate on PBX trunks groups are further processed. First, all calls that originate from a unique base are grouped under one originating trunc number. The originating base name is then added into positions 47-53 of the data base.

The final step of forming the edited form of the data base is merging the call records with the force element directory. This is the process of adding to each call record the force element code and called base. To perform this function, a force element directory exists that associates dialed digits with force element codes and bases. For each call in the call data base, the appropriate entry is found in the force element directory. (See Appendix G.) The four-digit force element code is placed into position 39-42 and the three digit base name abbreviation is placed into positions 43-45. The format of the edited form of the call data records is shown in Figure A-4.

4.0 Report Generation

The report generation program was created to generate listings of call data records from the data base. In addition, a variety of subroutines were generated to give special purpose reports.

The report generation program has the ability to list selected records from the call data base. A listing of the attributes that may be selected is given in Table A-1. When a list is requested, the data base is searched for all records that satisfy the

Field Description	Starting Position	Length	Hierarchy of Sort
1. Originating TG/TK	1	2/4	3
2. Initial time	5	6	4
3. Release time	11	6	—
4. Dialed digits	17	10	—
5. Precedence	27	1	—
6. Route	28	1	—
7. Terminating TG/TK	29	4	—
8. Originating switch	33	3	1
9. Called Base	36	3	—
10. Force Element	39	4	—
11. Precedence or Routine	43	3	—
12. Grade	46	1	—
13. Originating Base	47	7	—
14. Date	54	6	2
15. Holding time	60	6	—

Figure A-4
Format of Edited Call Data Records

conditions (equality only) specified. All such records are formatted and listed. Up to *ten* listings may be requested in a single run. The output will occur in the order of input requests. That is, all records that satisfy the first request will be listed contiguously, then the second request, etc.

Examples of the use of this listing program are given below. An example of the output is given in Figure A-5.

Example 1: List all records from Humosa. (HUM)

LIST ORGSWC=HUM

Example 2: List all records from Humosa in July:

LIST ORGSWC=HUM, MONTH=ϕ7

Example 3: List all records from Humosa on 20 July 1977.

LIST ORGSWC=HUM, DATE=ϕ72ϕ77

Example 4: Create two lists. The first is to list all records from Humosa on originating trunk group 60. The second is to list all records on originating trunk 6005.

LIST ORGSWC=HUM, ORGTK=6005

LIST ORGSWC=HUM, ORGTG=60

ORIG TG/TK	INITIAL TIME	RELEASE TIME	DIALED DIGITS	PRC	RTE	TRM TG/TK	ORG SWC	TRM SWC	AGENCY	MODE
0102	204503	204521	XXXXXXXXXX			1609	LKF			
0102	160747	160752	XXX2 XXXX	2	0	1300	LKF			
0102	134923	134928	XXX21459	4	0	1704	LKF			
0102	000910	000814	XXX2211021	4	0	8809	LKF			
0102	013715	013719	XXX2211021	4	0	8805	LKF			
0102	200846	200913	XXX2218545	2	0	8810	LKF			
0102	030322	030417	XXX2251110	4	0	8801	LKF			
0102	030430	030437	XXX2280123	4	0	1503	LKF			
0102	221014	221257	XXX2314123	4	0	8003	LKF			
0102	130056	130208	XXX2314123	2	0	8000	LKF			
0102	114724	114729	XXX2314123	4	0	1506	LKF			
0102	145208	145412	XXX2314590	3	0	8311	LKF			
0102	152440	152837	XXX2382893	2	0	8001	LKF			
0102	203716	203748	XXX3921511	4	0	8803	LKF			
0102	155205	155219	XXX3908893	2	0	1200	LKF			
0102	074450	074720	XXX3908893	4	0	8813	LKF			
0102	233330	233453	XXX3911151	4	0	8005	LKF			
0102	072700	072820	XXX3911151	4	0	8000	LKF			
0102	074432	074437	XXX3911151	4	0	1507	LKF			
0102	104848	105033	XXX3911151	4	0	8002	LKF			
0102	235129	235205	XXX3911511	2	0	8004	LKF			
0102	092453	092456	XXX3914578	2	0	8005	LKF			
0102	092506	092510	XXX3914578	2	0	8009	LKF			
0102	092523	092801	XXX3914578	2	0	8005	LKF			
0102	102352	102357	XXX3921151	4	0	1505	LKF			
0102	054500	054813	XXX3921131	4	0	8803	LKF			
0102	013735	014133	XXX3921511	4	0	8807	LKF			
0102	074331	074415	XXX3921511	3	0	8911	LKF			
0102	160802	160911	XXX3921511	2	0	8906	LKF			
0102	160903	160927	XXX3921511	2	0	8802	LKF			
0102	153647	153701	XXX3921511	3	0	8804	LKF			
0102	145117	145301	XXX3941151	4	0	8206	LKF			
0102	172851	173753	XXX3941151	3	0	8211	LKF			
0102	234939	235121	XXX3941151	2	0	8203	LKF			
0102	052353	052523	XXX3941151	4	0	8205	LKF			
0102	234917	234927	XXX3941511	2	0	8213	LKF			
0102	015044	015134	XXX3951151	4	0	8812	LKF			
0102	090605	090621	XXX3958845	4	0	8902	LKF			
0102	091220	091239	XXX3958845	4	0	8811	LKF			
0102	091254	091319	XXX3958845	4	0	8813	LKF			
0102	133747	133822	XXX3961151	4	0	2101	LKF			
0102	133834	133838	XXX3961151	4	0	1503	LKF			
0102	133847	133852	XXX3961151	4	0	1504	LKF			
0102	133904	133908	XXX3961151	4	0	1505	LKF			
0102	133912		XXX3961151	3	0	1205	LKF			
0102	133934	133938	XXX3961151	4	0	1506	LKF			
0102	125651	125655	XXX3961151	4	0	1505	LKF			
0102	125750	125753	XXX3961151	4	0	1507	LKF			
0102	125758	125802	XXX3961151	4	0	1501	LKF			
0102	130129	130134	XXX3961151	4	0	1503	LKF			
0102	101517	101552	XXX3961511	4	0	2126	LKF			
0102	120713	120730	XXX3961511	4	0	2126	LKF			
0102	124142	124146	XXX3961511	4	0	1506	LKF			
0102	124149	124153	XXX3961511	4	0	1507	LKF			
0102	111258	111449	XXX3971151	2	0	8903	LKF			

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